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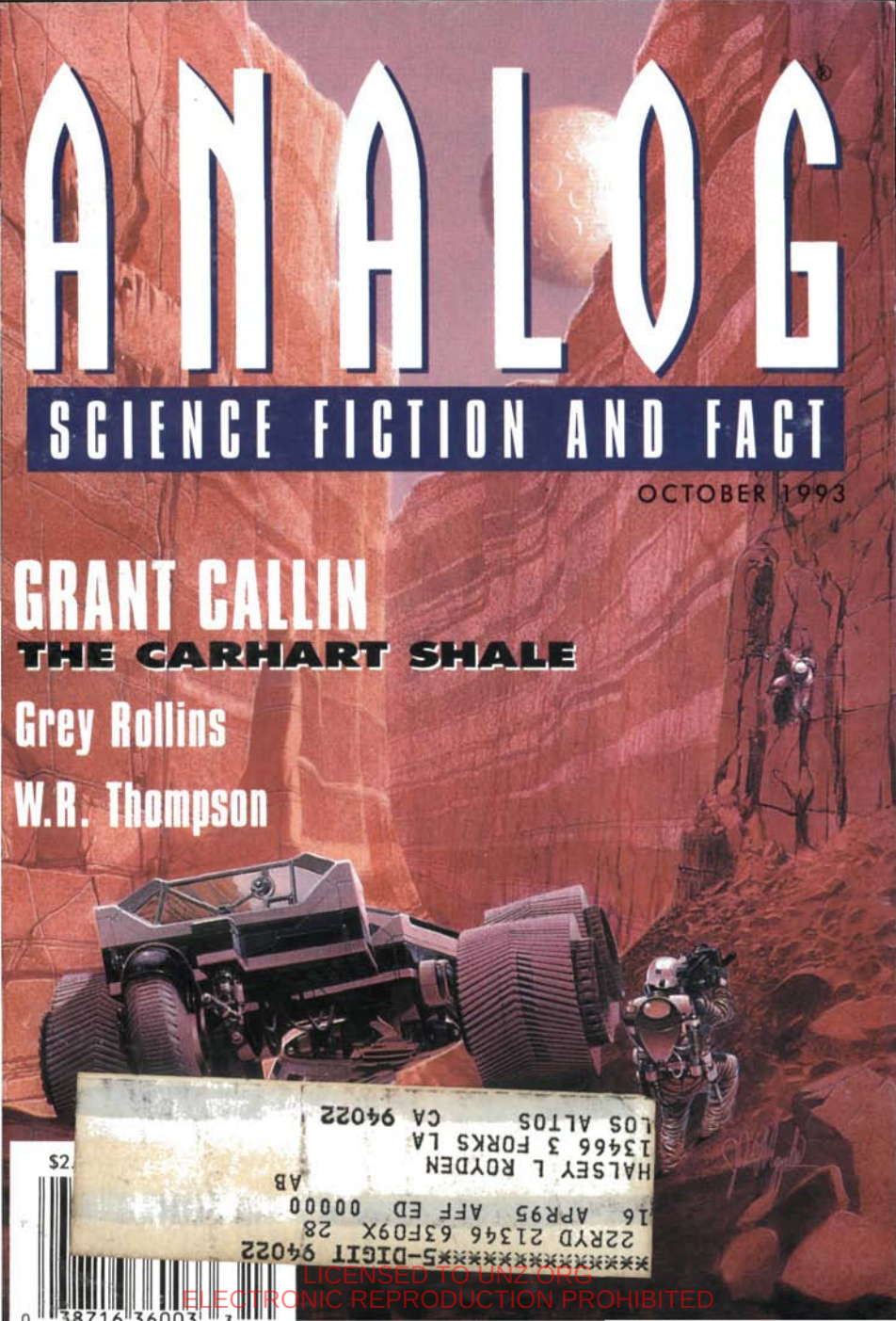

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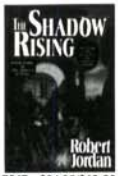

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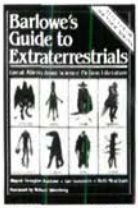

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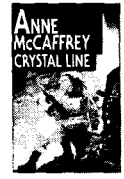

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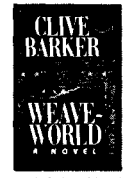

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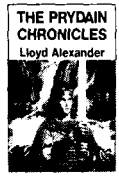

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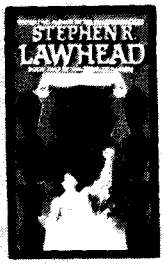

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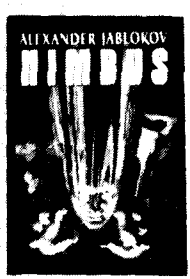

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EDITORIAL Stanley Schmidt

NOUVEAUX CLICHÉS

Not long ago I had a conversation with a promising new writer who mentioned that she, like many such, often meets with a group of other writers to "workshop" stories. At one point she mentioned that her writers' group sometimes criticized her work for a rather odd reason. "Why are you writing about these happily married people?" they asked. "That's such a cliché!"

"But it isn't," she objected. "Nobody else is doing it!"

Which is not *quite* literally true, but it *is* painfully close.

In rebelling against the clichés of "Leave It to Beaver" and "Father Knows Best," it seems, many of today's writers have created and adopted a whole new set of their own. Unfortunately, not many of them seem to have recognized yet that that's what they've done.

Marriage is just one example. Pick up a randomly selected story published almost anywhere in the last few years, and if a character is married, you don't have to read much more to be pretty sure that the marriage is falling apart. You *could* turn out to be wrong; but if you're a betting person, you won't find many bets with more favorable odds.

It's also an excellent bet that most of the characters will have more or less major psychological problems, and not much skill in dealing with them. The total cast of characters will very probably represent a mixture of races and genders in just those proportions deemed Correct by Popular Wisdom *circa* 1993. Their concerns and attitudes will closely mirror the set of contemporary fashions known by that odious label "Politically Correct."

All of these things have become so commonplace, so *predictable*, as to easily qualify for full-fledged cliché status. As Robert Coulson remarked in a recent review, "... there was a revolution in writing styles and editors today want stories based in the

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'real world' and characters who are 'real people' (spiteful, psychologically immature, sexually confused, self-absorbed, etc.)."

But how did it get decided that such people are more "real" than those who *can* manage their own lives, enjoy them, and be a source of joy to those who know them?

I flatly reject such a claim as faulty observation, because I personally know quite a few people of the sort I've just described. Yes, of course I know quite a few of the kind Coulson describes, too. But a literature that populates itself exclusively with those, and ignores the others, is every bit as clichéd as "Leave It to Beaver" or "Space Cadet."

"But," you may object, "even if it's true that there are some happy, competent people in the real world, they don't meet the needs of Literature. They're not *interesting!*"

Au contraire, say I. If happy, competent people are as scarce in reality as the current crop of Literary folk would have us believe, I should think they would be *very* interesting—as oddities, if not as role models or founts of inspiration. And if they're that scarce in reality, there must be lots of readers who could *use* them as role models or founts of inspiration.

This assumes, of course, that writers are capable of creating them. (Could *that* be the problem? I dare you. . . .) I'm not suggesting a wholesale return to the simple-minded Good Guys and Bad Guys of yore; there were good reasons for writers, editors, critics, and audiences deciding they'd outgrown those and it was time to move on to something else. I'm suggesting that now we've outgrown the present state of affairs and it's time to move on still further.

In deciding it was time to give more attention to Characterization, I think, many writers and critics moved from one clichéd extreme to another. Once upon a time Good Guys had no faults, which is a very rare condition among human beings. Now hardly anybody has any virtues—which is also rarer than many would have us believe. It has become commonplace—even *de rigueur*, in some circles—to confuse weak characters with strong characterization.

But strong characterization is not as simple as peopling stories with individuals who have made messes of their lives and can't figure out how to unmess them. It means a *variety* of characters who look and sound and

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feel so believable that a reader can imagine them, and be interested in them, as real people. (Note, by the way, that in general readers do *not* want realism, but *verisimilitude*, which is an entirely different thing. If you're not clear on the difference, look it up—and then think about it). Naturally those characters will have problems; problems, and people's efforts to solve them, are the very essence of *story*.

Some of those problems will even be psychological. Our readers, and I, are certainly interested in sympathetic portrayals of such people, provided they make the best effort they can to *do* something about their problems. But I would also like to meet an occasional someone in fiction who is so vividly portrayed that he or she seems real, yet whom I might like to know, and perhaps even admire and emulate, in real life. I am *not* interested in a steady diet of neurotic incompetents who make no effort to become something better. Look at it this way: if you're a writer, your characters are people I choose to spend my time with when I read your story. I'd like at least some of them to be people whose company I might seek out in real life.

There's at least one other thing that needs to be said in response to the worn-out convention that stories can't be interesting unless all their important characters are psychological disaster areas. Such a belief implies that the Universe contains nothing interesting enough to write or read about except corrupt and/or un-

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balanced minds and souls. Some people *do* believe this; William Faulkner is often quoted as saying, "The only thing worth writing about is the human heart in conflict with itself." But Faulkner was wrong. That's *a* thing worth writing about, and obviously one of special importance and interest to human beings. But to say that it's the *only* thing worth writing about betrays a dangerously narrow, anthropocentric, perhaps even arrogant attitude.

One of the fundamental precepts of science fiction—*real* science fiction, not thinly disguised mainstream fiction or fantasy that has misappropriated that label on some flimsy pretext—is the recognition that the Universe contains an enormous variety of interesting and important things. "The human heart in conflict with itself" is important to us because we *are* human beings; in the cosmic scheme of things, it's small potatoes. Since we normally see things from a human rather than cosmic perspective, human problems and conflicts are, should be, and will continue to be an important part of human fiction, including science fiction. The most memorable fiction usually has a strong impact on the emotions as well as the intellect.

But people who have anything resembling a realistic grasp of the scope of the Universe, and our place in it, will find a great many other things worth exploring. Sometimes those will even be the most interesting and important things in the story, and won't need to be shored up by bogging their protagonists down with miserable childhoods and failing marriages. Not only is it not necessary for every story to deal with the hidden recesses of badly warped or damaged psyches, it's not necessary for *every* story to put its primary emphasis on people at all.

If you think about it, you'll realize that that, too, is in keeping with real life. You neither need, want, nor have any occasion to learn about the innermost thoughts and hangups of most of the people you come in contact with. And if you're accosted by an armed robber in the midst of a skydive, you're not going to have *time* to psychoanalyze each other—but the purely external conflict can generate one heck of a story!

So how about we try to get a little more perspective back into our storytelling and our values for judging it? I pose three simple challenges:

1. *Don't confuse weak characters with strong characterization.* Give me interesting people to read about, but don't kid yourself that it's either necessary or sufficient to make them all seriously neurotic or unprincipled in order to do that. I've seldom liked a story unless I liked at least one person who lived in it. If you're telling me a story, I'd like to meet somebody in it whom I remember as real and worth knowing. Intelligence and integrity are *not* dirty words!

2. *Remember that human beings are not the center of the Universe, or even the only interesting thing in it.* Yes, I want to meet interesting, memorable people in your stories—but please don't burden either them or me with tedious details of their personal hang-ups if they have no partic-

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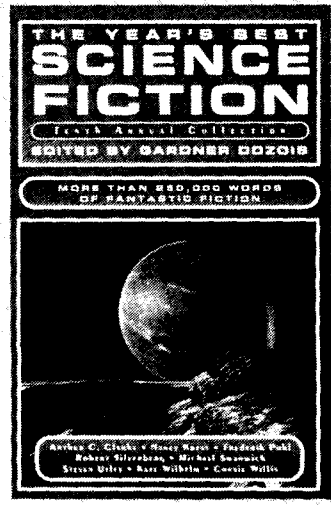

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ular relevance to the events they're caught up in and those events are themselves more interesting. And I hope that sometimes what's happening around the characters *will* be at least as interesting as the characters themselves.

3. *Dare to be fun.* Now that science fiction has become Respectable, many writers, egged on by Serious Critics, seem to be so busy trying to be Profound and Meaningful that they forget that the *first* purpose of all this is to *entertain.* This is not to say that everything in fiction should be sweetness and light, or that every story must have a happy ending. One of my all-time favorites is Daniel Keyes's "Flowers for Algernon," which would have been utterly destroyed by a happy ending. But a worldview, in fiction or in life, that is all bleakness and *Angst* is just as distorted as one that includes none of these things.

A reader once wrote that she was canceling her subscription to *Analog* because it failed to reflect her view that the world is a terrible place. I had to reply that it couldn't, because the world I've seen is *not* a terrible place. Or perhaps I should say that it is, but that's only one of its many, many aspects. The Universe is a terrible, wonderful, frightening, soothing, sad, funny, ridiculous, sublime, depressing, exhilarating place, and it's probably going to keep getting more so. I want my fiction, whether I'm reading it, writing it, or publishing it, to reflect all those facets, not just whichever of them some individual happens to fixate on. I hope you, as readers, will demand nothing less of those you read. ■

The ultimate result of shielding men from the effects of folly is to fill the world with fools.

Herbert Spencer

Men think it [*the brain*] is divine merely because they don't understand it. But if they called everything divine which they do not understand, why, there would be no end to divine things.

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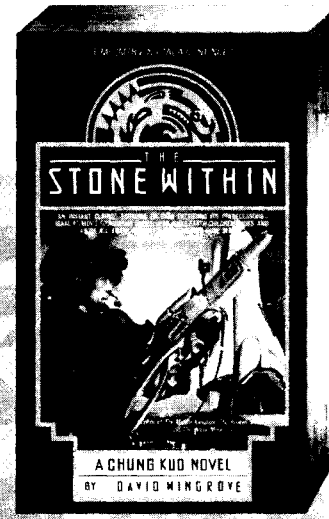

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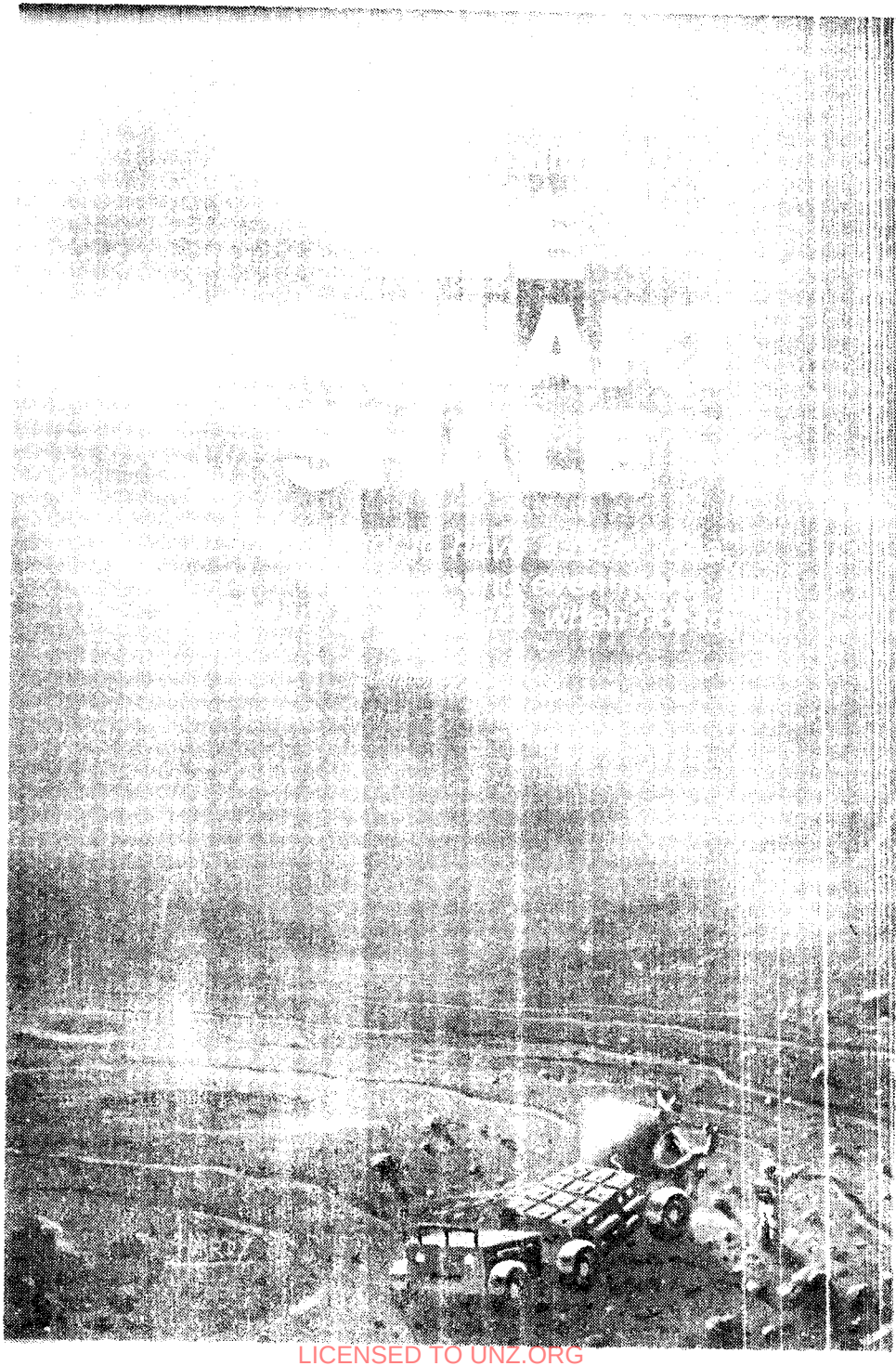

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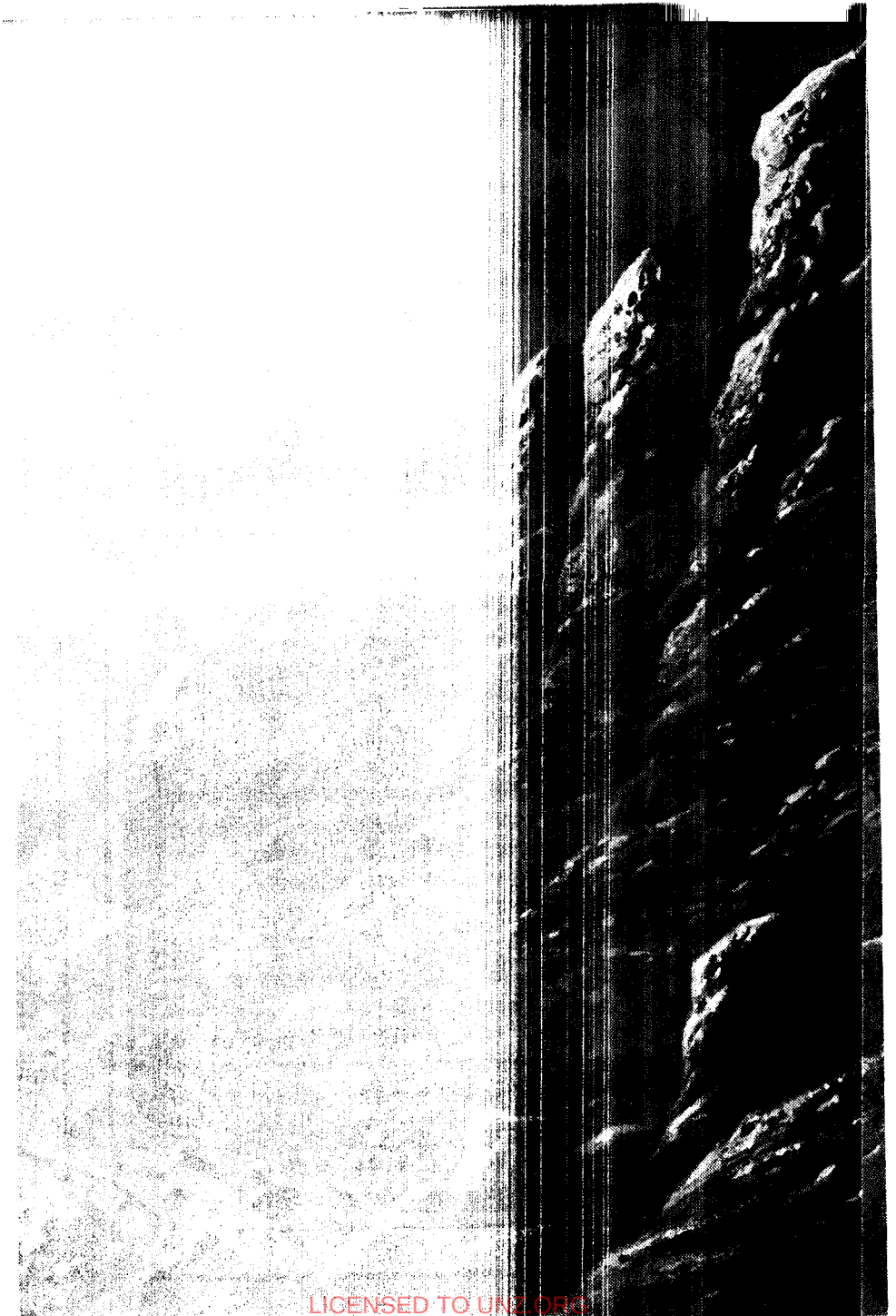

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Judy Aarness stood looking out through the tiny window while the teacher finished taking the class through its multiplication tables. Strange that a human should have to teach a simple rote lesson. But the colony had too many priorities to squander a thousand kilos mass on PC's and monitors.

The view out the window was east. From the settlement's vantage point near the center of Kiev crater, Judy could just see the top of the rim wall twenty kilometers away. The windmills lining it were plainly visible; their huge blades turned slowly, pumping precious kilowatts. Closer, she could see construction gangs erecting the gigantic towers from which the wire magnets would be strung to deflect incoming cosmics. When they were completed next year, the central thirty kilometers of the crater would be safe—no longer would they have to live in habitats covered by two meters of regolith.

And after that, the Dome. Twelve-hundred square kilometers of Buckyball acrylic to lid and pressurize the crater. Seven years, and they could walk around in their shirtsleeves and tend their crops and turn the farming robots into cars and computers. Shirtsleeves!

Her gaze drifted back to the rim, then she closed her eyes and let her sight leap without bound, beyond the rim and over Managla Vallis. Two-thousand kilometers to Arsia Mons, southern giant of the Tharsis Montes. She'd come back as leader of the second expedition, armed with thermal analyses from the orbiters which showed a significant heat flow from the volcano. So they'd put a landing craft smack in the center of the caldera to look for life—and they'd found it: strange forms of cyanobacteria, eating CO_2 and nitrogen, water and sunlight, and slowly replicating as they'd done for the past billion-odd years. Jack had made that expedition possible, and all the expeditions that followed. And these five thousand humans, beginning in their tiny way to turn the Red Planet green, the salmon sky blue.

Her mind's eye leapt again, another 2,500 kilometers to the heart of the Valles Marineris, then north just a hair till her seven-league boots were planted almost on the equator: Hebes Chasma. As the Earthers reckoned the seasons it had been nearly nineteen years. . . .

There was a change in the teacher's tone: ". . . And now, class, for that special treat I promised. This week we're celebrating the tenth anniversary of the first landing on Mars. Although"—she winked broadly—"the Earthers will have a twentieth anniversary of the event in less than a year. And visiting us today is our colony leader, Judy Aarness. She was one of the four astronauts who were the first people ever to set foot on our planet!"

As the teacher sat down, Judy moved to front-and-center and looked over two dozen young faces turned expectantly towards her. On Earth they might have ranged from six to nine years old; but here they were four or five—the first small crop, planted when the contraceptive

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rule was finally relaxed in the third year of the colony. The faces were multicolored, the eyes bright.

She smiled as she spoke: "I was going to talk about the Dome Project, and how by our fifteenth anniversary we'll be able to walk around outside without suits, but I changed my mind. Instead, I think I'll tell you a story. A story about the first expedition. Would you like that?"

The children clapped their hands. "Yes!"—"Yes!"—"Tell us about the liftoff in the dust storm!" "No—tell us about the Carhart Shale!" "Yes, the Carhart Shale!" "—the Carhart Shale!" "—Carhart Shale!"

Judy raised her eyebrows. "Oh, but I'm sure you've all heard that story a hundred times. Wouldn't you like to hear a different one?"

She saw consternation among the children that she might not recount their favorite. Then a hand thrust tentatively into the air, it was Frank and Yvette Mgumbo's little boy—what was his name? Sean, that was it.

"Are you Sean?"

He grinned self-consciously. "Yes, ma'am. And my daddy said if you were going to tell us a story, be sure to tell the one about the Carhart Shale, because, he said, you tell it the best of anybody!"

"Very well, Sean, I'll tell the story." The faces lit back up as if by magic, and hands began to clap again, until Judy held out her own hand for silence.

"Before I start, who can tell me: what *is* shale?"

A hand shot up instantly, followed by three that were less positive. Judy pointed to the first one, who seemed to be the oldest girl in the class. "Yes? Carmen Borodin, isn't it?"

"Yes, ma'am. Shale is a soft s-sedimentary rock, with lots of thin layers. And it's not very useful for anything," she finished in a rush, "—at least that's what my mom says!"

"Your mom is mostly right," said Judy, "and the people in Houston America, and all over the world who trained us in geology before we came to Mars, also thought it was useless. You see, we were looking for evidence of early life on Mars—life which died off billions of years ago. We were looking for the remains of tiny little plants or animals called microfossils.

"Now," she continued, "this next part is very important. Shale is *not* the right kind of rock in which to find microfossils. What you have to find is a harder kind, like chert. And *that's* what we were looking for on the first expedition—little pieces of chert, buried in limestone."

She frowned in concentration, trying to simplify the complex political and economic factors which dictated the thrust of the first expedition. "And it was important for us to find evidence of life on Mars, because the Earthers were tired of spending so much money for so many years to pay for the expedition. A lot of people wanted us to finish the first expedition, then not send any more people to Mars.

"But—" She lowered her voice and the children leaned forward in their seats, "—if we could find proof that life once existed on Mars, then maybe

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the people would regain their interest; then the other expeditions could go on as planned."

Her eyes took on a faraway look, and she stopped picking her words carefully. The children didn't mind; they were used to hearing stories in grown-up talk.

"So we chose Hebes Chasma as the first landing site. We knew from the orbital surveys that it was once a lake. And if we could drill through the regolith and get enough core samples of the sediment underneath, we just might find some hard layers or nodules of chert that would hold the microfossils we were looking for.

"Hebes Chasma is a box canyon with pretty high walls. But we found a way down with the rover...."

Colonel Sergei Ilitch Kabalevski straightened up from helping John Carhart seal a core into the rover's carrying case, and squinted his gaze southeastward. The rover's track was plainly visible, sunk into the soft regolith, meandering toward the morning Sun. Its depth justified the decision not to land in the chasma proper. On the other hand, if they'd landed in the valley, they might not have had to make a two-day journey and overnight in the little trailer pulled by their ugly vehicle. Sergei grimaced in distaste at its sleeping and sanitary facilities.

His eyes swung back around to Carhart, who had meandered over to the canyon wall, and was now poking around among the rocks at the bottom of a slide. Among the larger boulders were smaller pieces; he picked one up, and began hacking at it expertly with his pick. Briefly, Sergei was jealous of Carhart's field skills; his own talents lay in other directions.

Then his eyes moved compulsively up the cliffs. They rose nearly vertical for 2,000 meters, much more forbidding here than at the southern rim where they'd found a way down into the canyon. The rising Sun turned the flutes into huge, tapered stripes of light and shadow. The effect was spectacular, even though softened by the swirling dust now filling the thin atmosphere.

Sergei frowned; the dust seemed to be noticeably thicker than half an hour ago. He opened the comm channel to the landing base by pressing a button on the side of his suit.

"Toy, this is Hebes, over." In 1979, when the USGS put the first map of Mars together from the Mariner pictures, it arbitrarily gave every crater over ten kilometers a two-letter designation, depending on its longitude and latitude within a given map quadrant. Just south of Hebes Chasma was a large, shallow crater designated in this manner as "Ty"—or more properly, "Coprates Ty." Fifty years later that was still the official designation—but the crater had been called "Toy" ever since the expedition formed.

This is Toy. Go ahead, Hebes.

"The dust seems to be worse down here. What's the latest from Phobos, over?"

We really woke 'em up back on Earth. The visual feeds from the orbiters and the Phobos camera are being linked directly to the big weather

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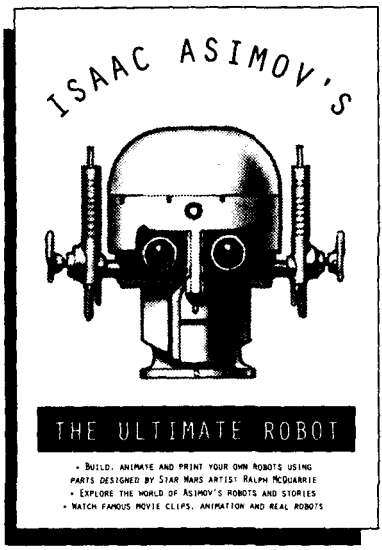
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computer in Kansas City. It says we've got the Mother of All Storms brewing here. It may even be bigger than the storm of '09. The Phobos crew are hopping mad; they're not going to get their twenty days down, over.

Kabalevski grunted sympathetically. The twenty-two month expedition allowed only forty days total in Mars orbit. The mission plan for the eight-member crew was for the first four to land at Hebes Chasma while the others stayed on the advance base at Phobos, observing and tending the fuel/oxy manufacturing facility. Then after twenty days they would switch, with the second crew landing at Mangala Vallis. The Mangala complex was a more promising site for geological science—the Hebes Chasma landing was politically motivated.

Now the entire mission would be cut short after only eleven days. The wind velocities and quantities of dust from a planetwide storm were too much of a risk for machines and people.

"How much time do we have, Sergei?"

Carhart had been listening to this side of the conversation on his own two-way link. His question interrupted Kabalevski's gloomy speculation on the political consequences of the dust storm.

"I'll find out. Toy. How long until we have to lift off, over?"

Hebes, the refined estimates from the Earth computer say that it gets really ugly here in about twenty-six hours, plus-or-minus two. Houston wants us out of here ASAP: eighteen hours, twenty max, over.

Toy Base was fifty kilometers due south. To get there, they had to traverse almost the whole width of the valley floor, then snake up the southern rimwall along the switchback that was mostly natural, with a tiny bit manmade. The "manmade" part had cost them eight days of labor, while the other two crew members drilled for water on the narrow strip of high ground between Hebes and Toy.

Then yesterday, they'd set off on a three-day foray to get samples from the valley floor. They'd traversed down and begun a counter-clockwise loop, stopping every five kilometers to take two-meter cores. Last night at dusk they'd reached the northern rimwall. That was when they first got word that a dust storm had started in the Hellespontes mountains on the western border of Hellas Planitia. Normally, a storm seven-thousand kilometers away would not be disturbing. But the Hellespontes were infamous: most of the planetwide storms observed over the past century had begun there. They'd spent an uneasy night because of the news.

When they queried Toy Base first thing in the morning, they got bad news and good news. Bad: the storm was spreading with great speed and looked to be headed for planetwide involvement. Good: they had time—enough to get a few more samples and return with plenty of margin.

"Understand, Toy. Lift-off in twenty hours. We see no problems with that. We estimate sixteen hours traveling time from here to there—eighteen hours max—so we'll see you after

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dark, over."

Roger that, Hebes. In the meantime, we'll button up here and complete the checklist. When you get back, all you'll have to do is transfer your samples and climb in the boat, over.

"Roger *that*. You're going to have two tired travelers on your hands. Over and out."

Toy Base out.

Kabalevski shut off the link and spoke to Carhart: "Twenty hours, Jack. No problem."

"Good," said Carhart, bringing over the piece of rock he'd been dusting off. "I want you to take a look at this."

Carhart handed him the rock, and pointed to a darker spot on the face near one edge.

"What do you make of that?"

Kabalevski peered at the thing. It seemed nothing more than a sooty smudge. "Maybe an inclusion?"

"No," said Carhart, pursing his lips. "Do you know what kind of rock this is?"

Kabalevski looked carefully at the specimen. It was grayish green, noticeably different from the monotonous ruddy regolith covering the canyon floor. He turned it sideways and peered more closely; it was a layered structure. He wrinkled his forehead in concentration, trying to remember painfully learned geology lessons.

"Shale?"

"Yes," said the other, "and look at the sharp edges; this is a fresh slide—less than a million years old. Now look up the talus, about five or ten meters above the top of the fall." He pointed with his whole arm so that Kabalevski could follow with his eyes. "See the layer? It's a thin one, and only about twenty meters long."

Kabalevski nodded without speaking as Carhart continued: "It's something we haven't seen yet—a shale stratum. And it's got to be old, since it's near the bottom of the canyon wall."

Carhart turned his head back to the piece which Kabalevski still held in his gloves. He spoke slowly, tapping the rock for emphasis: "I think this specimen came from that stratum, and I think that discoloration is an animal fossil. And I think I ought to climb that talus to get some more specimens."

Kabalevski stared at the other in disbelief. A small man, balding early, Jack Carhart was the most unassuming of the eight crewmembers. During the long months of confinement on the outbound voyage, he'd done his daily exercises and performed his duties without complaint; he spent his free time mostly alone, reading from his allotted ten gigabytes of computer storage. The only notable fact about the man was that his mind appeared to hold an incredible store of trivia; other than that, he was entirely undistinguished. Kabalevski was the leader of this two-man excursion; and he'd frankly rather have had one of the other crewmembers along, to cope with possible emergencies. But Carhart was the most experienced geologist among them, and an excellent amateur paleontologist to boot. Any other choice for his partner would have been rank favoritism.

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Now he stared down at the other's visor, caught speechless by the uncharacteristic request. He saw Carhart's face only dimly, through his own reflection on the faceplate. When he finally found his voice, he spoke with emotion rather than logic. "That's impossible."

Kabalevski didn't even know himself whether he was talking about the idea of a large fossil, or about the difficult climb up the talus with a planetwide dust storm kicking up. Carhart chose the obvious one to answer:

"So they say." Then he paused; Kabalevski could see him purse his lips inside the helmet before speaking again: "Sergei, during practice for this mission back on Earth, how many core samples did you pull?"

"A couple of dozen, I guess."

The smaller man's head nodded inside his helmet. "About average for the crew. Well, I've pulled hundreds, from all kinds of terrain all over the Earth. Most of the time I can tell just from the feel of the sampler going down what we're going to find inside. And I'll tell you right now that we haven't pulled a single chert nodule—hell, we haven't even found any limestone. And on the surface we haven't seen anything that even vaguely resembles a stromatolite formation. What we have is regolith—oxidized, poisonous dirt that's going to get us nothing but sneers when we get home.

"And now," he waved his arm toward the dust swirling in the southern sky, "the expedition won't get anything else. We're finished. And with the mood back home, it might be Mars that's finished, too."

As he became more intense, he took the rock back from Sergei's hand and waved it in the air. "But now, we have something that might be truly remarkable. It's worth an extra half hour, even now, to go for it."

Kabalevski took the rock back from Carhart's hand, and looked at it. "Why can't we just bag this one and call it a day?"

"Sergei, you know the answer to that as well as I do. If that stratum up there is a true fossil bed, we're going to have humans swarming all over this planet for a generation to come. But if we go back with a single specimen—no photographs, no corroboration—we're going to have every other politician and media hack seeing who can shout 'Hoax!' the loudest. We'll be lucky to raise another dime of funding in the next ten years."

Kabalevski was still bemused by the other's uncharacteristic ardor. Astonishingly, he found himself debating the pros and cons of Carhart's idea. He looked up again to the layer of shale and said half to himself: "That cliff looks pretty steep—dangerous to climb." But as he studied it further, he saw that the section past the top of the talus might just be navigable, given an experienced climber in good physical condition.

"OK," he said, coming to a decision. "I'll go up; you stay here and record with video."

Jack's laughter was completely without malice, so Sergei couldn't get angry with him.

"Sergei, I've seen you use that pick;

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balanced up there on that ledge, you'd be more likely to split your hand than the shale."

Kabalevski relented. He looked up toward the cliff again and said: "Don't go any farther than the top of the slide until you get up there and can report a definite safe route to the shale."

"Roger that, Sergei." Carhart had hooked his pick and a pair of baggies to his belt, and was already grabbing for handholds on his way up the big boulders at the bottom. "Get the video on me."

Sergei stepped back to the crawler, pulled the small camcorder from its niche, and activated it as he walked back to the bottom of the talus. When the scene was in focus on the monitor, he started to record visual. Then after a moment's thought, he activated the audio recorder link. As he zoomed from the wide angle to zero in on the shale, then down to Carhart climbing the talus, he spoke formally: "Colonel Sergei Kabalevski recording exploration of a possible site of macroscopic fossil life. General location: Hebes Chasma floor, at central northern wall. Specific location: shale stratum approximately sixty meters above canyon floor. Indications: possible fossil-bearing shale specimen, bagged as Hebes 11-04, found at bottom of 50-meter-high talus currently on camera. Climbing talus is Dr. John C. Carhart, whose voice will also be on this record. Because of strenuous activity required, further audio will be informal."

He checked the monitor to see that Jack was above the most physically taxing part of the climb, then asked: "Dr. Carhart, why do you think that there might be animal fossils in the stratum?—it goes against everything we know about the evolution of Mars."

Carhart's voice was a little ragged from the exertions of his climb, but had a note of confidence that Kabalevski was glad to get on tape: "I've been to Brandon Bridge; and I've made the thousand-meter climb up to the Burgess shale. I've examined first hand pieces of rock that held fossil photographs of the explosion of life at the beginning of the Cambrian. I know what they look like. So when I broke open that specimen and saw what was inside it, and thought of the color red, something clicked inside me."

"Red? Oxides?" asked Kabalevski.

"Red." Carhart continued to speak firmly: "The color of Mars, of fire and blood, destruction and war. The Babylonians called him Negral, the Raging Fire God. The Chinese Ying-Huo, the Fire Planet. The Aztec Huitzilopochtli, the fire-being who destroyed people and cities."

He paused to catch his breath; he was laboring near the top of the talus now, sliding back half a meter for every meter he gained. A steady stream of rocks, loosened by his boots, was tumbling down the talus. As Kabalevski watched, a small one bounced down off the large bottom boulders and landed at this feet. "Careful," he said.

Jack continued without paying attention: "Yes, we know it's oxides, mainly iron. Red is the color of oxygen; the whole planet's lousy with

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it—even the dust is poisoned with oxidizers. I think there was a lot more in the atmosphere at one time than anybody else thinks. It was there early, when conditions were warmer and there was standing water on the planet. There was enough, maybe, to raise the dissolved oxygen content of the water to the point where it would support evolution of multicellular—"

Hebes, Toy Base, Hebes, this is Toy Base, over.

Kabalevski hurriedly switched off the audio, but continued to record video as he answered the call: "Toy, this is Hebes, over."

Bad news, Hebes. We're back in contact with Phobos. They've made another pass over the center of the storm, and found that it was a lot worse than they thought yesterday. Now they're telling us to do our damnedest to get off as soon as possible. Houston's orders are for us to try to catch the ten-hour tick rather than the twenty-hour one. And if we can't make that, just get into orbit and waste fuel matching with Phobos. What's your situation, over?

"We're at the north rim of the canyon; ETA at Toy is sixteen hours, plus-or-minus two, over."

There was a perceptible pause before Toy's reply. *What the hell, Sergei? That was the same status you gave us half an hour ago, over.*

Kabalevski picked his next words carefully: "We found a geologically interesting stratum on the north wall of the canyon, and we're getting samples, over."

They'd better be awfully good, Hebes, or Houston will really be pissed—hell, they'll be pissed anyway, over.

"Understand, Toy. We'll get wheels up right away."

Roger, Hebes. We'll compute lift-off for nineteen hours from now. Please estimate the mass of the cores you're bringing back, over.

"Fourteen cores, Toy. Estimate one-hundred forty kilograms."

We copy, Hebes: fourteen cores, one-hundred forty kilos. Now shake your butts and get back here, over and out.

As Kabalevski signed off he automatically switched the audio back on, then became aware that Carhart was whispering to himself: ". . . Mother of God, mother of all Gods . . ."

He interrupted the other harshly: "Jack, quit muttering up there, and get down off that slope. The storm's getting worse, and we've got to run."

Carhart's voice was still hushed as he responded: "Sergei, do you know what I'm putting in this bag? A piece of shale with a fossilized animal over two centimeters in length, complete with dozens of palps."

"Fantastic, we're famous," said Kabalevski. "Now shake a leg and get down here. We're late for a date with Phobos."

He saw Carhart look upward toward the dark-colored layer before he answered: "Sergei, we've got to be sure it's that stratum. Ninety-nine percent isn't good enough. Keep taking pictures; I'm going up."

"Jack, I'm ordering you to come down now."

"Begging your pardon, Colonel, but it'll only take ten minutes, and

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we've got to have verification. I see a way, and there looks to be a ledge, just below the stratum, that I can work from. While I'm going up, why don't you radio Toy Base and tell them what we've got here. We could use a positive headline or two."

Sergei was now angry, angrier than he had been in years. Even taking into account that Carhart was a civilian, his flouting of Kabalevski's authority was inexcusable. He took a deep breath to shout at the other—but by then the little man was plastered against the cliff, negotiating a difficult traverse back toward the shale stratum.

So he called the base instead:

"Toy, Hebes. Toy Base, this is Hebes, over."

The reply was garbled, and interrupted by bursts of static: *... ebes, th... Toy Base... you moved since ... st transmission, over?*

"Toy, Hebes, Toy, Hebes. Your transmission is poor. Repeat: transmission is poor. We have not moved since out last transmission. Repeat: we have not moved since our last transmission, over."

Heb... oy. Hebes, T... ay parabola seems... hunting. We speculate that... dust into the mech... Repeat: relay... hunting. We are ... tching over to manual... peat: switching ... sssssss. ...

There was nothing but static after that. Kabalevski held his breath and strained his ears, but there was no carrier in the signal. He swore under his breath.

"Toy, this is Hebes. Toy, this is Hebes, over."

He listened again: nothing but static. Kabalevski felt a nervous tightening of throat and stomach muscles. He looked back up at his companion, to see that he'd finished the traverse, and was just settling his feet onto the small ledge below the shale stratum. He closed the channel to Toy Base and spoke to Carhart: "Jack, are you secure?"

"Roger. Sounds like you got a bad link with Toy."

"Worse than that," replied Kabalevski: "We lost contact in the middle of our conversation—probably dust in the pointing mechanism of the relay antenna. It must be thick up on top."

"I'm not surprised," said Carhart. Then: "OK, I'm going to dig into this rock now. You still got the video cranked up?"

The little man was relentless. He tried one more time, even as he panned along the cliffs to zoom in on the climber: "Dammit, Carhart, get your ass down here—now. We've got real trouble at base, and we've got to move."

"It shouldn't be more than a couple of minutes, Colonel," was Carhart's unflustered reply. Through the monitor Kabalevski could see that he was looking closely at the cliff wall. "If the two samples I picked up from the talus are a statistical representation, the whole stratum is lousy with fossils."

With the last word, he proceeded to throw his pick into the cliff; then he pulled it back and repeated the process. Kabalevski could see that he was working awkwardly, balancing

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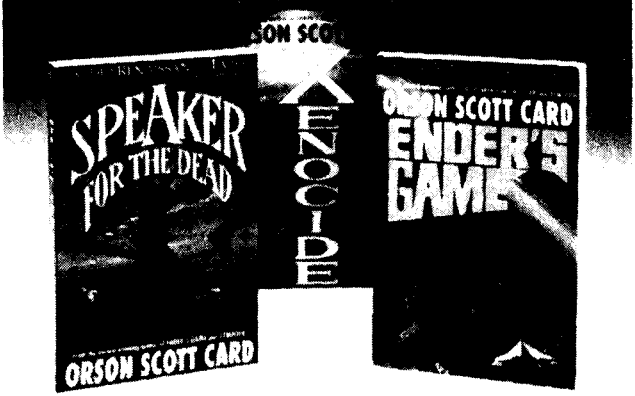

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on the ledge without much leverage.

The colonel checked to make sure the audio was on, and zoomed in on his partner with higher magnification. Then he waited for what seemed an interminable time before finally hearing Carhart say: "Got a man-sized piece here. Just one more second while I check it."

Kabalevski watched through the monitor as Carhart swung the pick deftly to split the big rock in his hand, then peered closely to examine the cleaved surface.

"Unbelievable. There are two fossils visible on this surface: one nearly three centimeters, one about half that size. This is the mother lode without a doubt." He proceeded to hold up the specimen with the cleaved face toward the camera. "Can you get a close-up of this?"

"Roger," said Kabalevski, knowing what was coming. "The shape is plainly visible in the monitor for later verification."

"Good," said the man on the cliff. "This sample is too large to bag; I'm going to carry it down by hand—we'll put it loose in the sealed box for examination at Freedom." Kabalevski watched him carefully put his pick on the suit hook. Then, holding the rock in one hand, he stepped gingerly backward off the ledge.

It happened before he got his lower leg planted: the ledge broke off right under Carhart's foot. Since his whole weight was momentarily on that leg, he never had a chance to recover. In an instant, he was falling sideways toward the top of the talus ten meters below.

The low gravity turned it into a slow-motion horror show. Clutching the specimen to his chest, he put his other hand out to break his fall at the beginning of the rockslide. Kabalevski had one second to wish Carhart would drop the specimen and use both hands to save himself—then it was too late.

As the little man hit the top of the talus, Kabalevski could actually hear a snap just before the "Aaa-a" torn in anguish from Carhart's throat. Then he was rolling down on top of the small rocks at the top of the pile. Kabalevski knew that there now were rocks of all sizes tumbling down toward him, and there was something in the back of his mind telling him that he should run away from the bottom of the talus as fast as his legs would take him—but the spectacle of disaster rooted him in place.

Carhart kept spinning in slow motion, screaming in pain each time his body rolled over the broken arm. His good arm still held the specimen tucked into his belly. Kabalevski shouted into the mike for Carhart to let go of the sample and use his good arm to help stop his roll, but all Carhart did was to begin screaming, "No! No! No!"

Instead he spread his legs, trying to slow down and turn himself so that he was sliding feet first instead of rolling. He seemed to be succeeding; and his efforts galvanized the other, who hastily set down the videocam and began to move closer to the bottom of the talus.

But then Kabalevski's attention was grabbed by a large rock bounding

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down at him. He dodged out of its path—but needn't have bothered: the boulder hit an even larger one ten meters up and bounced high over his head. Instinctively Kabalevski turned to follow its flight, and watched with sinking heart as it hit the rover amidships, then rolled across the battery array and off the rear end of the vehicle.

Moaning with helplessness, he jerked his head back around. Carhart had finally succeeded in turning his roll into a feet-first slide. He was nearing the large rocks at the bottom of the talus, and beginning to slow down. But just when it seemed that things were stabilizing, his foot caught between two large boulders. This stopped his forward momentum, but with a terrible price: his leg twisted unnaturally behind him, up under his back. He gave one final scream, which died out as he came to rest about fifteen meters above. He didn't move, and didn't answer when Kabalevski called him.

The colonel scrambled up to the other man, resisting an impulse to run recklessly up the boulders; he had to be careful, since he was now Carhart's only hope for survival. The body was lying head downslope; the leg was free now, but still twisted. And miraculously, the suit was pressurized, and the integral PLISS still functioning. Kabalevski said a quick prayer of thanks for the rigorous design specs and the Dave Clark Company, then pushed his hand firmly onto the chest area. He felt movement; Carhart was still alive.

The fatal piece of shale was lying

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by Jack's open hand; he'd let go of it only after losing consciousness. Sergei picked it up and underhanded it carefully out onto the soft regolith in front of the rover. It was difficult lugging the inert body back down to level ground over the large boulders at the bottom of the scree; Kabalevski was panting and sweating before it was finally done.

Thankfully, Carhart remained unconscious through it all, for it would have been painful; and what he had to do now would cause even more pain. He laid the little man down beside the rover, then tugged and straightened the leg as best he could. Jack moaned softly, but did not regain consciousness.

Sergei knew that he needed to get Jack inside the pressurized trailer to give him medical attention, but there was no way that was possible. Their suits were "backouts": they were built to be used outside and kept outside, so that the dust they carried would not contaminate the habitats. One entered a pressurized space by backing up against a special airlock which mated with a large ring on the back of the suit. When the ring was situated correctly it sealed automatically, and robotic mechanisms opened the airlock and the back of the suit; the astronaut then backed out of the suit into the habitat. It required an athletic effort to use the back-in lock; and the trailer was too small to be equipped with a full airlock.

Kabalevski managed—with much cursing—to get Carhart into the righthand seat in front of the rover, then strapped him in, waist and shoulders. Then, panting from his exertions, he went back to inspect the damage to the rover. One dust guard was bent; it was no problem to straighten out the flimsy material. But the hardest hit area was the conduit, carrying current from the batteries to the motor. Ironically, it had been placed on top of the rover because it was safer there than underneath. He pulled a big rock—it must have massed thirty kilos—off the conduit run. Three of the six conduits were damaged: one was torn off and the wires broken, which meant that two of the batteries were out for sure. He carefully checked the switch-box leads to the forward computer; they seemed OK.

He went back to the foot of the talus and retrieved the camcorder, ejected the casette and slipped it into an arm pocket on his suit before tossing the camera into the back of the rover. Then he walked the ten meters to the piece of shale that might have cost Carhart his life, picked it up, and brushed off the reddish-brown regolith. One side was rough, the other cleaved cleanly by Carhart's pick. He saw two sooty spots on the cleaved side, one about a centimeter and a half in diameter, the other almost three. He looked closely at the larger spot, holding the rock so that the Sun shone on its face. The blotch was shaped like a miniature blunt sausage with three appendages at one end; on the inner curve were eight regularly spaced projections. It was an animal fossil beyond doubt.

Sergei took the rock back to the

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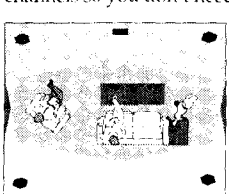

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rover and put it on the floor by Jack's feet. Then he looked carefully down into the other's visor; he saw a massive bloody area around the right collarbone. He shook his head and checked to make sure that the broken arm was immobilized by the safety straps.

Kabalevski levered himself into the left seat, switched power on, and checked the control panel. Four of the twelve batteries showed open circuits; everything else seemed to be functional. It wasn't as bad as it might be; the rover would be OK on straight-and-level; it needed only six batteries for a nominal speed of six kilometers per hour, even in the deep regolith of the canyon floor. But going up the rim would be something else; it would require the full current from ten or eleven of the batteries to make the steepest pitches.

"Well, Jack, we'll worry about the south wall when we get to it." He spoke to Carhart out of subconscious need; the dangers of the situation were building pressures inside him, and talking was an outlet.

He started the rover up, and headed it back along their outbound track. The decision was governed by the decreasing visibility; he could no longer see the south canyon wall. The curved outward path would cost them several extra kilometers, but he'd be able to make better speed following the deep, pre-formed ruts in the regolith.

"Going to backtrack, Jack. No surprises that way, and it'll be the smoothest ride for you."

The panel indicators showed that the computer was doing its job, shifting the load among the eight working batteries. He looked at the clock; fifty minutes had passed since he'd lost contact with Toy Base. That meant they'd already used up forty-five minutes of slack he'd built into the estimate; and would undoubtedly use up a lot more on the south wall climb. He increased pressure on the accelerator until the rover was making eight kilometers per hour. The ride at that speed was bouncy; when Carhart groaned a little, he eased it back to seven.

"Sorry, Jack, we'll take it a little easier—but we'll still make good time. Six, maybe seven, hours to the south rim."

After a few minutes, Kabalevski opened the comm link to Toy and tried once more to call:

"Toy Base, this is Hebes; Toy, Hebes, over." He got nothing but static in reply. Peevishly he mumbled, half under his breath: "Silly name for a base. Toy. Come to think of it, Hebes Chasma is even sillier. Why Hebes?"

And much to his astonishment, Carhart answered: "Hebe was the daughter of Zeus and Hera, the goddess of youth." Then he coughed. Kabalevski was surprised into speechlessness until Carhart continued: "For a while, she was cupbearer to the gods—but was replaced by Ganymede; the word around the Pantheon was that he got the job because he was Zeus's favorite lover. So after Heracles died and became a god, Hebe married him and settled down to anonymity." He coughed some

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more, then groaned.

Kabalevski finally found his voice: "It's good to have you back, Jack. We're on the road, heading back toward the south rim. ETA about six hours."

Carhart said: "I won't make it. I'm dying."

"That's ridiculous," said Kabalevski. "You're not dying, you're talking to me."

"A man knows when he's dying, and I know." He coughed again before continuing: "That leg break was bad. Damn zero-g osteoporosis. Bone must have cut an artery on its way out through the skin. I think my whole right suit leg is filled with blood."

"Then, by God, we'll get you into the trailer and get the bleeding stopped." Kabalevski had to force the words out past a lump in his throat.

"C'mon, Sergei," said the other weakly. "We both know that's not going to happen. I'd faint from the pain before you could even drag me from this seat."

Kabalevski said: "Well, dammit, you hang on anyway! The worst is over; just a ride back to Toy, then into orbit." He didn't mention the four useless batteries.

"Sure, sure," Carhart replied, then sighed and lapsed into silence.

Now that the wounded man was conscious Kabalevski felt reluctant to speak, for fear that Carhart would tax his strength by replying. The eery silence was broken only by Carhart's fast, shallow breathing while Kabalevski drove the rover in its big arc from north to south under the mid-morning Sun of the Red Planet. He estimated the velocity of the wind now at fifty kilometers per hour; in the thin Martian atmosphere it was pushing at them with the equivalent force of only the slightest of breezes on Earth. Far worse were the effects on visibility and equipment: the ultra-fine grains got into everything that wasn't carefully sealed—and even some things that were. Now, as Kabalevski looked over his shoulder, the dust had concealed completely the hated northern wall—but it was still too early to be able to glimpse the south wall. During that hour Kabalevski experienced ultimate frustration: he had a dying man less than a meter away, but could do nothing to help him but keep driving and hope.

It was Carhart who finally ended the long silence: "I'm going to tell you the story of the Cambrian explosion."

Kabalevski immediately replied: "You should be resting now, not telling sto—" then broke off when he realized that Carhart hadn't stopped talking.

"...You remember it, because it's important. Life on Earth began early, almost as soon as the impacting ice balls brought enough waters to cool the surface and make lakes and seas. The Sun was warmer then—enough to keep the water standing on the surface until it turned to organic soup. The soup provided materials and zinc clays were there for templates. It only took a few million years of experimentation before replicating proteins were present in their billions; then followed cells with membranes, that

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could reproduce themselves and cover the seas. . . ."

Carhart's voice had been getting softer and softer, and now he paused to breathe fast for a few seconds. Kabalevski spoke into the silence: "Jack, shouldn't you not try to talk and—"

"No," interrupted the other. "I need to finish. I'll make it simple—so even you can understand."

Kabalevski laughed politely, then stopped abruptly because Carhart was continuing again.

"—Anaerobic cells, the cyanobacteria, dominated . . . filled their ecological niche, changed CO_2 and sunlight to oxygen, put the oxygen into the atmosphere. When it had oxidized everything it could on the surface, O_2 built up in the atmosphere—"

He coughed again, and paused again to catch his breath. Kabalevski didn't try to interrupt this time.

"—And when enough built up, it was reabsorbed into the seas, and another ecological niche was created—and filled by eukaryotic cells, with nuclei and other organelles—cooperatives of prokaryotes that could reproduce as a complex grouping. Some of the complex cells were still CO_2 eaters—the blue-green algae and their cousins; but some were oxygen eaters; the amoeba-cousins, ancestors of the animals."

He was silent for a while, then said vigorously: "You getting all this, Sergei?"

"Most assuredly, Jack," said Kabalevski.

"Good," said the other. "Hmm, I'm thirsty. Storytelling is dry work."

"Sip some water from your nipple," said Kabalevski.

Carhart said: "I tried—doesn't work. Besides, what I really want is scotch. Pinch—no, Glenfiddich. Haven't tasted Glenfiddich for two years." He coughed again, then said: "Where was I?"

"The amoebas," prompted Kabalevski.

"Oh, yes. The oxygen level in the waters continued to increase, until it reached a magic concentration where another ecological niche was created—and populated by organisms with specialized cell groups that could reproduce sexually and diversify: the animals. The niche was filled almost instantly in geological time . . . an event we call the Cambrian explosion. That was just 600 million years ago. Before that, single-cell life had dominated Earth for three billion years."

The little man paused for a long time, breathing heavily. Kabalevski spoke: "OK, Jack, I've got all that. Now why don't you—"

"Quiet, Colonel," Carhart interrupted again. "I'm on a roll. Now we're gonna talk about Mars. Here, there wasn't enough time to build up the oxygen necessary for a Cambrian explosion—it was lost too early by gravitational escape; therefore if life did evolve here, it must have remained in the simple prokaryotic stage."

He laughed harshly. "It's true—just ask the experts." He laughed again, but it ended in a cough. He cleared his voice and continued: "Except they're wrong. Every time we probe

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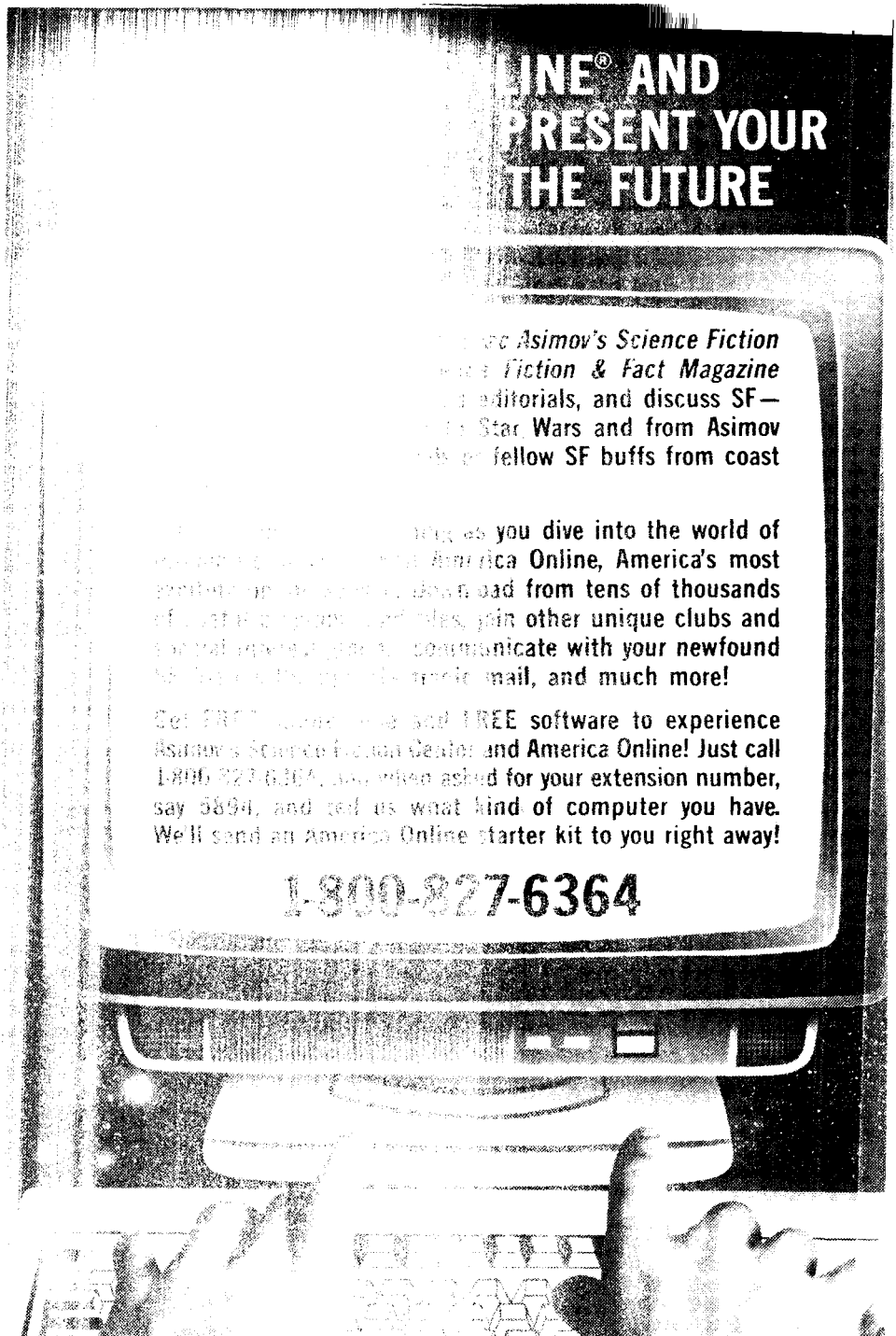
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a little farther from the home planet, experts get their little wagons upset. This one's beautiful. The experts think what has happened here can't happen. They'll be swarming all over the planet trying to figure it out. And you'll lead them back to do it."

He was quiet for a long time after that. Kabalevski tried once again to contact Toy, hoping they'd somehow fixed the antenna on the south rim. But he knew they didn't have time; they were only two crewmembers performing a checklist meant for four. He drove on toward the inexorable confrontation with the southern rim wall.

During that period, Carhart spoke only three more times. The first was half an hour after he'd finished the story:

"... Dying but brain keeps working. Physics is physics. The planet's oxygen was long gone half a billion years ago. So the explosion had to happen long before it did on Earth. Two, maybe three billion years ago. Figures ... Mars was always in a tearing hurry to get things done ... started his career by raping the vestal virgin Rhea Silvia—that's how Romulus and Remus got planted. But then the core cooled too quickly ... plate tectonics stillborn ... couldn't recycle CO_2. The larger forms died off ... probably nothing left now but a few anaerobic bacteria, hiding from all the oxygen poisoning ... maybe in the calderas. God, I'm thirsty."

Kabalevski's response was weak: "We'll be getting some water into you pretty soon; we're only a few kilometers from the south wall—then up to Toy base."

Carhart said, "Liar," then was quiet again.

An hour later Kabalevski had hit a bump, and Carhart spoke as if a switch had been turned on:

"Maybe they'll call it Jack's shale." Then, louder: "Sergei, you've got to make it back, to show them! You've got the shale?"

"Yes," said Kabalevski. The lump was back in his throat.

"Good," said the little man, then lapsed back into silence. A few minutes later he spoke for the last time.

"The pain's gone ... I can't see anything ... damn, there's so much to do now. ..."

Carhart breathed very quietly for a few seconds after that, then let out a long, soft sigh and stopped. Kabalevski turned the comm all the way up, and heard only silence.

There was nothing to do but keep driving. Kabalevski felt an overwhelming sense of loss and helplessness—and guilt. He should have gone for the shale—should have insisted. But would he have succeeded? Very possibly not. Jack Carhart, who had been the least imposing member of the crew throughout the entire trip, had turned into a tiger, had enforced his own judgment at precisely the correct moment in history; his last hour had been his finest. So be it. And he would embrace Carhart's imperative: the most important thing in his life would now be to get back to Toy Base with those remarkable specimens.

The mission TO called for the expedition to leave the rover and trailer

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in a shelter near Toy Base as a legacy for future exploration. Now, without compunction, Kabalevski stopped the vehicle, climbed out, walked back and undid the simple hitch, letting the tongue fall into the dust. Then he climbed back into the left seat and accelerated the rover to nine kilometers per hour.

Four hours later he was at the southern wall, surveying the tangled series of rock slides that constituted the road out of Hebes Chasma. He couldn't see the top—it was too dusty—but knew the rim was there, two kilometers up. He now faced twenty kilometers of switchbacks—and after that, a few straight-and-level kilometers to Toy.

"Well, Jack, here we are." He'd been talking to Carhart for the past hour. "Now comes the hard part. Gotta get up these cliffs with only seven of our batteries working." Another one of the batteries had unaccountably failed during the southward trek.

They began the struggle upward, all batteries on line, speed varying from slow to slower depending on the pitch. Kabalevski could have walked up faster—until his out-of-shape body ran out of breath and energy. He was acutely aware that his own life, Carhart's legacy, and the immediate future of Mars exploration, probably depended on the ability of the rover to make it back up the twenty kilometers of rim wall slope.

A fourth of the way up, there was a pitch that was too steep. Kabalevski was ready; he'd planned his order of battle long since, during the mindless hours of the trek across the valley floor.

"Time to dump the bad batteries, Jack. I was hoping we wouldn't have to put out the effort."

They had just negotiated a hairpin, and had started up the pitch; the rover was inclined perhaps twenty degrees. On Earth, it would have been quite frightening; here it was just mildly so. Kabalevski set the handbrake firmly, checked the control panel a final time to be sure which batteries were out, then climbed gingerly out of the front seat. His first act was to find two large rocks and put them behind the back wheels of the vehicle. Then he attacked the batteries.

The simple tools in the rover's kit were adequate for the job. He took the coupling covers from the two that weren't already entirely broken off by the falling rock, and pulled the couplings out of the batteries. Then he unscrewed the tie-downs. The batteries were high-tech wonders, but they still massed sixty kilograms each. Kabalevski had to climb up, lift them by the handles, carry them to the back edge, leaning back against the slope, and drop them off. The job was difficult and dangerous. He was puffing after the first one, and sweating profusely after the fifth. When it was done he climbed back in the front seat and rested, panting, while his cooling system cleared the sweat-fog off his visor.

"Would have been nice to have had your help, Jack."

When his visor had cleared a little, he checked the clock: nine hours

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since he'd talked to Toy just before the accident. Three hours since they'd started up the south rim wall. They'd come four point eight kilometers—and had about fifteen yet to the top.

"Doesn't look like we're going to make our ETA, Jack. Wonder how long they'll wait—wonder how long Houston will let them wait." He twisted his body to look back downslope. He could make out the valley floor about half a kilometer below, but not much more; the dust was still thickening, and blowing now at seventy or eighty kilometers per hour. It was eerie to see all that activity and not hear anything—except the slightest tick as an occasional large grain was thrown against his visor. He turned back around and looked up; the top of the wall was lost in dust.

"Let's crank it up." With a silent prayer he went to full acceleration and released the handbrake. The rover crept slowly up the slope. When it reached the top of the pitch, the speed picked up and Kabalevski's heart lightened.

Five hours later and half a kilometer farther off the valley floor, Kabalevski was swearing under his breath and clumsily backing out the screws that held the sample container in the rover's belly. The fourteen cores they'd collected—and sixteen empty core holders—were already strewn on the slope behind. Kabalevski had hoped it would be enough to throw them off. It wasn't. And now it was almost dark.

Kabalevski remembered this pitch well: it was a frightening 30 degrees. It was 400 meters long, and the slope would actually increase by a few degrees about one-fourth of the way up. And with all the cores and extra holders dumped off, the rover still barely crawled upward on this first part. That meant the vehicle would be stopped again 100 meters upslope.

The sample holder was not designed for quick removal; forty-eight screws held it in place, and they weren't easily accessible. It took a full half an hour, and many contortions, to get them all; therefore, the swearing. When he was done, he climbed carefully down from the rover's midsection and pulled it over the side, making sure it wouldn't hit any of the wheels. Then, heart pounding from his exertions, he got back into the driver's seat and started the rover going again. It pulled slowly up the slope.

"Maybe that extra fifty kilos'll do the trick, Jack."

But it didn't. A few minutes later the rover slowed and stopped; the batteries could just hold it without it starting to roll back downhill. Kabalevski set the brake again, cut power, and faced a spiritual crisis. There was nothing else removable—except Jack and his suit. Removing their mass would make an enormous difference in the rover's performance. But the thought of leaving the body behind was anathema. There was an overwhelming need for Kabalevski to get Carhart back to Toy, and to Earth, for a proper hero's burial. Yet it was logical—it was *necessary*—to leave the body.

But now that it had come to it, he

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still wasn't ready to do the logical thing. He got carefully out and forced himself to perform the now-familiar ritual of blocking the back wheels. Then he went around to the right side of the rover and unstrapped Carhart's body.

With the rover sloped so steeply, it was almost impossible to horse 100 kilos of mass out of the seat. He had to brace one foot against the side of the rover, and heave with all his strength. And when the body came out, it fell on top of Kabalevski and bore him to the ground, trapping his legs and causing a sharp pain in his left shin. The icy-cold rocks digging into his back drove him up quickly, ignoring further pain as he grabbed the bottom edge of the rover and pulled his legs out from under the body.

Panting with the effort of freeing himself and standing up, he quickly checked the heads-up display; the suit retained its integrity. He took a tentative step and winced with pain, but the leg was able to bear weight. So he took a deep breath, stooped down, grabbed Carhart's body by the shoulders, and began pulling it upslope.

Twenty minutes later, he'd pulled the body less than 100 meters. His chest was heaving, his heart was pounding almost uncontrollably, and his visor was fogged with moisture his PLISS couldn't clear fast enough. He squinted upslope in the gathering darkness; 200 meters remained until the next hairpin where the grade eased off—and he knew he was beaten. If he were fresh, he might

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make it up there; but the hard day yesterday, the restless night, and this day of increasing stress, had taken too high a toll of Kabalevski's strength. But those factors didn't weigh in his heart. What mattered was that he needed to get Carhart's body back to his comrades, and he couldn't do it. Tears of frustration and guilt welled in his eyes.

He shook his head to clear the cobwebs, then knelt down and pulled the body to one side of the primitive track, ignoring the racing of his heart. He stacked four flat rocks to make a cairn beside the body, then stood for a moment looking at the pathetic monument.

"I know you don't need this body any more, Jack—but dammit. . . ."

Then threw the body a salute, turned around, and started back toward the rover. He had to lean back against the slope and walk gingerly so he wouldn't pick up too much speed. He limped a little; his shin hurt like the devil.

Back in the rover the first thing he did was get the flashlight out of its compartment and check the clock: over fifteen hours had passed since he'd talked to Toy. About four more hours to the top, then one more to Toy on the straight and level. Praying that his last stop was behind him, he turned on the rover's lights, once more applied power and released the brake; the rover went up the steep slope very slowly, but it didn't falter.

"Looks like we're going to make it, Jack."

Five minutes later, he rolled past the body.

"We'll be back to render you proper honors, Jack."

Twenty minutes after that the slope reduced dramatically; the rover picked up speed and Kabalevski's heart lightened again as much as possible, with night closed in and the wind growing in force.

Three hours later another battery went out; the rover slowed, but kept going. Shortly after that two more went, almost simultaneously. The rover began to roll back downslope. even though the grade was less than 15 percent. Kabalevski hurriedly set the handbrake with a foul curse.

"Well, Jack, that big rock must've done more damage than we thought —or else that dust is eating its way into the circuitry." He got gingerly out of the rover, winced and almost lost his balance as he put weight on his bad leg—the bruised muscle next to the shin bone had stiffened badly.

He performed the tiresome ritual of blocking the back wheels, then used the flashlight to examine the array of remaining batteries. He couldn't see anything wrong. He flashed the light at the clock up front: almost nineteen hours elapsed since his estimate to Toy of—what was it? Sixteen hours, plus-or-minus two? Three? How long to troubleshoot? How long to take out the three dead batteries? And would the rover make it anyway?

He forced his tired brain to do some dead reckoning, and came up with the hopeful thought that it couldn't be much more than a couple of kilometers to the rim.

"We're in luck, Jack; I think those

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batteries lasted long enough for us to make it to the top—if my legs hold out."

Kabalevski walked around to the shotgun seat, took the two baggies with the small shale specimens and clipped them to his waist-belt, one on each side. Then he pulled the larger specimen from where he'd put it—how many hours ago?—on the floor space in front of the right seat.

It was heavier than he remembered—it must have massed five or six kilos—and it would get heavier before he was through. Then he thought of its message, straightened his shoulders, and started up the slope, flashlight in the other hand.

"Stick with me Jack; I think I'm going to need your help."

After one hundred steps he paused to rest, heart pounding again. "Got to . . . pace myself, Jack . . . keep reminding me. If I do it right, I ought to . . . to be able to make almost as good a time as the rover."

An hour of toil passed. His body was a machine on overload; it required firm instructions from his brain not to lie down and sleep. The body negotiated for a rest every fifty steps instead of every hundred. The brain compromised and gave it seventy paces. "Help me keep count, Jack . . . I keep getting my twenties and thirties . . . mixed up."

Another hour. Kabalevski was finishing up his twenty-third rest. *OK, legs, time to get moving again.* His body told him firmly that it refused to go another step. *Just one more try,* said the brain. The body still refused. *Look,* said the brain, *I promise that if we haven't made the top by the end of the next forty paces, we'll lie down and join Jack.* This was the fifth time he'd made that promise; it worked one more time. His left leg moved forward and up; the right followed; they weren't big steps, but they were something.

Twenty-six slow paces, and then he noticed something: the wind was increasing dramatically. He could actually hear it now: a thin keening—and there were larger grains of dust in it; he could hear them rasping against his suit. And he could actually feel the force of the wind, coming from the left front; he had to lean against it a little, and it made his progress more difficult.

"Damn it, Jack, don't . . . I have troubles . . . enough? Now the . . . wind's picking up."

He could hear Jack laughing at him, and wondered why . . . then realized a marvelous fact: he must be feeling the wind from the top of the rim. Hardly daring to hope, he moved the light upward—and there was no more slope, just a gentle lip. He croaked a laugh and stumbled up and over into the deep rover tracks in the regolith; the dust had half-filled them, but they were still there.

"Toy Base, Toy Base, this is Kabalevski, over."

ssss—Base—sss—status, over.

"Toy Base, Kabalevski. Toy Base, this is Kabalevski. I read you one by two. I read you one by two. Status report: Carhart is dead, and so is the rover. I am on foot at the top of the rim, and in distress. Request you send the auxiliary rover as soon as possi-

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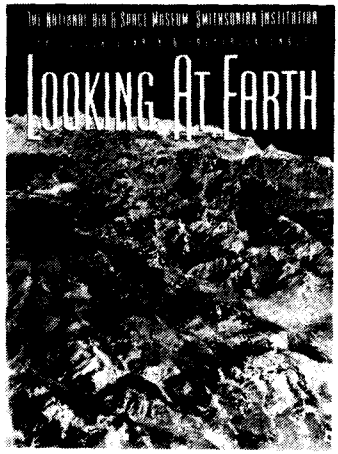

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ble. Repeat message: Carhart is dead, and rover is disabled. I am in distress and require immediate assistance, over."

Kabalevski, this is—ss—Base—ssss—stand your message—sss—send Riko with auxiliar—sss—diately while I recompute—ssssss—peat: Riko—sss—her way with—sss—rover. Do you—sss— stand, over?

"Toy Base, Kabalevski. Understand your message. You are sending auxiliary rover to my position. Repeat: your message is understood. You are sending rover to me at once. . . ."

Twenty-five minutes later, he was seated blissfully in the auxiliary rover's right seat, with Nakano driving pell-mell through the dark and dust back to Toy. She was full of questions, but Kabalevski wouldn't talk.

"Later, Riko, please. I need to rest, now."

His rest was short; in fifteen minutes they were at the lander. They both used the full airlock, leaving their dust-laden suits in the outer chamber. Kabalevski brushed the dust off the big rock as best he could and took it inside the vehicle.

Judy Aarness was in the pilot's seat, busy with checkout. Kabalevski made for the water supply, grabbed a squeegee, and emptied it slowly into his mouth; his suit's supply had run out several hours ago. More strength returned with the water.

While he was drinking, Aarness finished and turned her couch around with a sigh. Kabalevski cut off her impending questions with one of his own: "What's our status, Judy?"

"We're an hour and a half past our max allowed time on the ground. This storm's about twice as ugly as we thought when we last talked to you. Phobos and Houston are so pissed off you wouldn't believe it. Based on our instrument telemetry, they're giving us less than a fifty-fifty chance of making it now. Personally, I think they're full of crap; our flight computer's fully functional, just two of the thrusters have gone over to backup, and the only thing wrong with the main engine gimbals is a little sluggishness in yaw. Seems to me we're more like seventy-thirty."

"How long to liftoff?" he asked.

She glanced over to the mission clock. "Twenty-three minutes; I've just given full control to the computer. So while you're getting your butt into the chair you can tell us what happened to Jack—and what is that rock that's getting dust all over my clean deck?"

Kabalevski looked down at the piece of shale in his hands. The two smudges were plainly visible; the larger one's appendages were prominent. He smiled to himself and spoke under his breath: "They're really there, aren't they, Jack?"

"What did you say?" asked Kaoriko.

Kabalevski said: "Is Phobos on the comm?"

"Yes," said Aarness. "They came into line-of-sight two hours ago, and are under orders to record all voice until we dock."

"Good," said Kabalevski, "because I have a story to tell you." He smiled again. "A story about the Carhart Shale. . . ."

* * *

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The smaller children clapped their hands and cheered, amid the sighs and thoughtful looks of the older ones. One of the latter raised his hand. It was Sean Mgumbo; Judy noticed that the arm was very muscular. Sean was going back to Earth next month to attend college; he'd been diligently working out in the high-*G* centrifuge.

"Yes, Sean?"

"Ma'am, my father thinks that it was you, and not Colonel Kabalevski, who was with Carhart on the expedition down into Hebes—and that you were a great heroine to get the samples back to Toy Base. Is that true?"

She frowned and put a little steel into her answer: "Sean, you know perfectly well that the members of the first expedition made a pact to keep the name of the other person confidential. The reason is that the identity of the other is not important; what he or she did was not heroism—it was just doing a job and not giving up. It could have been any one of us—Colonel Kabalevski, Kaoriko Nakano, or myself. In fact, it *was* all of us in spirit. But the real hero was Jack Carhart—"

Now Sean's and two other hands were up. She held out her own to forestall them. "Please, let me finish; this is important. We know now that fossil-bearing shale is common on Mars—so that its discovery on the first expedition wasn't the huge stroke of luck that we thought at first. . . ." She smiled before continuing: ". . . it was just a *little* lucky. The important thing that Carhart did was to seize the luck—to recognize what he'd found, and have the courage to disobey orders and scramble up the cliff to make sure of his find—knowing perfectly well that it was extremely dangerous to do so. It was those qualities which made it possible for us to be here today, celebrating the fifteenth anniversary of our colony. . . ."

She left the classroom early, and went out into the warm sunlight under the Dome. She strolled eastward, following her shadow along a path between tilled fields; her nostrils flared at the rich smell of night soil. When she walked past a working farmer, he stopped to tip his hat and speak a respectful "Afternoon, Ma'am."

Ma'am indeed! All adults in the colony were on first-name terms—except for her. For the past several years, they'd been saying "ma'am" to her, and calling her the Matriarch of Mars behind her back. What a load of crap! She let her gaze drift up over the rim wall, out to infinity, and spoke under her breath:

"I hear you laughing, Jack. But I'll be damned if I'll let them make *me* a hero. Tomorrow, I'm going to hang it up. Maybe I can wangle a job at one of the polar stations, working on the Atmosphere Project. Hell, I'm only sixty-seven. . . ." ■

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Richard Terra

WORKING MOLECULES: PROGRESS TOWARD NANOTECHNOLOGY

The concept of *molecular nanotechnology*—that is, the idea that human beings will achieve precise, controlled manipulation of matter at the atomic and molecular level—was first articulated in a serious, unified form by Dr. Eric Drexler during the early 1980s. Most initial responses viewed the concept as, at best, a distant goal for future generations, or, at worst, science fiction fantasy masquerading as theoretical speculation.

But many found the idea impossible to ignore. If Drexler was even partially right, the development of such technologies would have profound effects in all aspects of our lives. Because we have not yet attempted to create the sort of advanced molecular machines envisioned as the end result of a mature nanotechnology, there remains a good deal of uncertainty about just how close we will actually be able to come to Drexler's vision of fine-scale, reliable control over atoms and molecules.

However, the increasing pace of advance in a number of scientific fields seems to indicate that the development of some sort of molecular-scale technology is very nearly inevitable. This article attempts a survey of some of the more important advances that have been made.

Progress toward functional molecular devices is being made along two approaches. The first is "from the bottom up": research into the design and fabrication of small molecules that can be built up into larger and more complex assemblies, leading eventually to functional machines. The second is a "top down" approach employing current macroscopic technology to manipulate materials, even individual atoms and molecules, to assemble components into larger and more complex arrangements, again eventually leading to functional molecular-scale machines. Both lines of research are far from this final goal, but have achieved promising results.

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* * *

BIOLOGICAL SYSTEMS

One of the most compelling lines of evidence for the validity of the concept of molecular nanotechnology is that such machines already exist. Natural biological systems offer the best current proof that molecular machines are possible, and capable of doing productive work. As such, the machinery of life stands as a sort of "existence proof" for the field.

Examination of biological systems yields other useful lessons. Over the course of about four and a half billion years, terrestrial life has been shaped by evolution according to the basic principles of molecular behavior. By studying biological systems, we learn about those basic principles. That evolutionary legacy also represents a reservoir of potential components we might adapt for use in molecular machines of our own design.

Some of the most dramatic advances in our ability to manipulate and design complex molecules lie in the fields of protein chemistry and protein engineering. In nature, proteins play a number of essential roles, acting as both structural and functional components in all living cells. Perhaps the most familiar are the enzymes: proteins which catalyze the molecular reactions and transformations that are the essence of life.

Protein chemistry also forms the foundation of today's biotechnology industry. Many of its most important products are themselves proteins, extracted from large cultures of cells. In many other cases, the protein machinery of cells is harnessed to produce the desired product.

But biotechnology is not nanotechnology: it continues to rely on traditional methods of bulk biochemistry. It is something like knowing how to program an automated factory to produce cars or toasters without knowing how to design or build the factory itself. Perhaps the most useful gains from biotechnology are an understanding of complex molecular behavior, and a set of rudimentary tools for working at that scale.

Can proteins serve as nanomachines? In one sense they already do, in living systems. But can they be harnessed to the tasks of manufacturing and computation that we usually associate with technology? This seems unlikely: in many respects, proteins are too weak, too unstable to be suitable for such a role in mature nanotechnological systems. But they may serve as models for understanding the function and design of molecular mechanisms for gripping, manipulating and effecting transformations on other molecules. More importantly perhaps, they may provide an intermediate step toward advanced nanotechnologies based on more stable, more durable materials.

We are still a very long way from even these more limited goals. The behavior of proteins is horrendously complex, and we still lack anything like full understanding of their structural and functional characteristics.

A protein is composed of a linear sequence of amino acid sub-units; this is referred as its *primary structure*. Usually, segments of this amino acid chain will form helical and sheet-

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like segments; the most common patterns are the alpha helix and the beta sheet. This first-order folding is known as the *secondary structure.* These may then undergo further folding to create a complex globular formation referred to as the *tertiary structure* of a protein. Finally, individual proteins may bind together into a supercomplex, sometimes referred to as a *quarternary structure;* hemoglobin is one example, in which a quartet of complete proteins form a larger complex. The overall pattern of a protein's folding is referred to as its *conformation.*

Currently, we lack a fundamental understanding of protein folding and conformation, and their relationship to protein function. Since the final shape of a protein determines its function, such understanding is vital. In addition, our knowledge of how proteins function in their natural environment is incomplete. Most of our knowledge of shape and function is based on studies of immobile, pure, crystalline proteins; as yet we know very little about their dynamic behavior in living systems.

But over the last decade or so, significant progress has been made in these areas. Through traditional analyses, the amino acid sequences, conformations and functions of a wide variety of proteins has been determined. Primary sequences are determined much more easily than folded secondary and tertiary structures; by the late 1980s, for example, over 8,000 amino acid sequences were known, but only about 300 folded conformations had been determined.

However, these numbers are increasing at an accelerating pace, enlarging the database of known structures. This expanded knowledge has led to important advances in developing a workable theory of protein chemistry and function, and in the infant field of protein engineering.

One such advance was the discovery that natural proteins are constructed from a large but limited number of structural and functional modules, or "domains." The overall size of this repertoire of modular components is still a matter of heated debate, but the discovery of these patterns of conformational arrangement has given new impetus to the study of protein structure, function—and design.

Other valuable insights have been gained by examining how proteins take on and maintain their final, functional shape as they are synthesized in their natural environment. For decades it had been thought that this process was largely spontaneous, occurring according to factors that minimized the energy of the interactions between the various components of the protein chain. And indeed, some progress has been made in understanding the "protein folding problem" by modeling such favored minimum energy pathways.

In the last few years, however, molecular biologists have also discovered the folding process is not always entirely passive or spontaneous, but is in many cases guided by "chaperon" proteins. These molecules apparently inhibit protein folding pathways that lead to nonfunctional dead-

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ends, promote favorable folding, and perhaps even provide templates for difficult (i.e., energetically unfavorable) folding events. An understanding of how such systems work at the molecular level may provide valuable lessons in shaping components for molecular machines.

Another technique that is yielding useful insights as well as practical results has been to make single, relatively simple modifications to existing proteins and study the effects on form and activity. This line of research has encouraged rapid advances in our knowledge of the role played by individual amino acids in protein chains, by primary and secondary structural elements, and how they determine protein function. Indeed, this method has proven so fruitful that a separate specialized journal, *Protein Engineering,* has been established to publish research results in the field.

Several different types of modifications can be made. In the simplest, single amino acids at specific sites in the chain are altered or another is substituted, replicating natural "point mutations" that often play a significant role in evolution. It was this work, in part, that led to the discovery that many protein sequences exhibit what has been termed "degeneracy": different amino acids often play similar, redundant roles, and many different combinations of relatively similar amino acids can produce structurally or functionally similar domains in a protein's final conformation.

Others have gone beyond altering single amino acids at one or a few sites to altering whole segments or domains, or to recombine domains in novel configurations. These experiments have yielded further insights into the problems of protein folding and arrangement.

To test their understanding of the principles gleaned from these studies, researchers have also made numerous selected, specific alterations in protein structures to achieve predetermined, calculated effects. Since the early 1980s, various proteins have been successfully modified to achieve greater temperature stability, accelerate reaction rate, change the preferred substrate on which an enzyme acts, and a number of other characteristics. By the late 1980s such modifications had become a standard analytical and experimental technique for investigating protein structure and function. Slowly, step by step, we have been learning the basic principles of protein design.

These lessons were put to a much more ambitious test in the late 1980s, when a team of researchers led by Lynne Regan and William DeGrado of DuPont attempted to design and synthesize a protein molecule from first principles, rather than simply modify an existing natural form.

Working on the assumption that it would be easier to design a folded protein structure than to predict the folding of natural sequences, the DuPont team chose a final target configuration and selected the amino acids they thought appropriate to create it. This approach allowed for the design of relatively simple, easily

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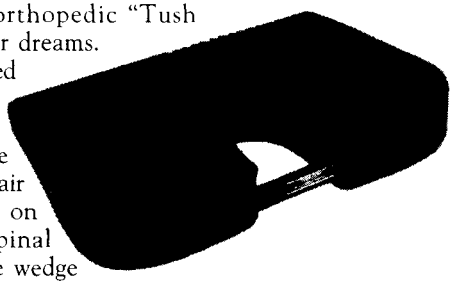

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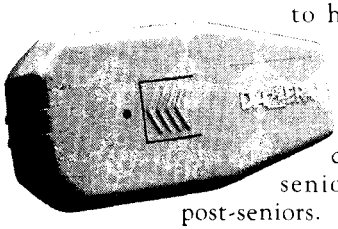

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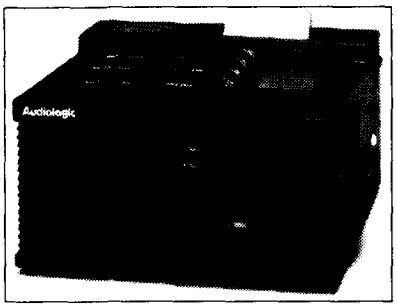

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understood structures, as well as the use of amino acids not found in natural systems.

In 1988, after two years' work, the DuPont researchers announced their success in creating a new protein modeled on a natural arrangement of four alpha helices, but designed entirely from scratch. This new protein, called alpha-four, was quite stable; in fact, under comparable conditions, it was *more* stable than the natural analogs on which it was modeled.

Two years later, in June 1990, three University of Colorado researchers announced they had succeeded in creating the first artificial enzyme—a functionally active protein—by design. Over the course of two years they had designed a framework of 73 amino acids to support 3 strategically placed side-chains which replicated the active site of chymotrypsin, a natural digestive enzyme.

The Colorado team made extensive use of computer models of the chemical and thermodynamic characteristics of their design. Synthesis was successfully completed on the first attempt, which took two months. The synthetic enzyme, called Chymohelizyme-1, or CHZ-1, bound the same substrates as chymotrypsin, but had a reaction rate roughly 1,000 times slower; however, this was still 100,000 times faster than the uncatalyzed reaction. CHZ-1 was the first enzyme designed and assembled entirely from scratch, with the intended form and function. The creation of *de novo* proteins and enzymes remains a very active area of research.

A related field of molecular biology has also produced promising steps toward molecular nanotechnology: the modification and design of novel molecules derived from antibodies.

Antibodies are very specialized proteins. Like enzymes, they possess sites for highly specific recognition and binding at the molecular level. However, they do not normally catalyze reactions; rather, each type of antibody binds very specifically to a target molecule, called an *antigen,* usually a substance foreign to the body. The bound antibody acts as a marker that triggers an immune response by the body's defenses.

During the 1980s researchers began studying antibody binding in great detail, and discovered the binding site often stretches and distorts the chemical bonds in the target antigen, much as an enzyme's active site does in catalyzing a reaction. This similarity was readily noted; the question was whether antibody binding was strong enough to break bonds or encourage their formation.

Theories of enzyme action suggest the active site binds to or encourages the formation of a high-energy "transition state" that would not form as readily without the enzyme's assistance. If antibodies could be tailored to bind in a manner that facilitated the formation of the appropriate transition state, they too would act as catalysts. The central problem lay in creating antigens that would encourage the formation of such an antibody: if the transition state is unstable and transient, how could it persist long enough to act as an antigen?

This obstacle was in part solved by

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using transition state analogs: stable molecules that *resembled* the desired transition state form, which prompted the formation of the appropriate antibody. This strategy proved highly successful: by the late 1980s the creation of catalytic antibodies, or "abzymes," was an area of intense research activity. These custom-made molecular catalysts often had reaction rates hundreds, thousands, and in a few cases millions of times higher than uncatalyzed rates. This approaches, but does not yet match, the efficiencies of natural enzymes.

The first abzymes were capable only of breaking weak bonds in relatively simple molecules. And most abzymes still act only to cleave bonds, not form them. A few have been created that successfully catalyze synthetic reactions, but these have been much harder to design and culture. By the early 1990s researchers had made abzymes specific to dozens of reactions, and had begun to engineer their binding sites, adding special co-factors to help speed reactions, and to refine the natural supporting protein to make them smaller and simpler. They were, in effect, following a parallel course to protein and enzyme researchers in attempting to create novel molecular forms with a defined structure and function.

These are only two of the more important lines of research in biology that may enable the development of molecular nanotechnology. As the study of biochemistry and molecular biology reveals more and more details of the workings of living systems, our understanding and our capabilities for performing useful, directed work at the atomic and molecular scale will advance. Examples of natural components in biological systems that may teach us how to build familiar machine elements at the molecular level are presented in Table 1.

Just how far this study and modification of biological components might take us toward functional nanotechnologies remains to be seen. It seems likely that protein-derived molecules will play some role in hybrid or transitional molecular technologies leading toward a mature, full-blown nanotechnology. But some limitations to this approach are already apparent.

Living systems are the product of aeons of evolution, and evolution is a loose, undirected, stochastic process, without foresight or purpose in its designs; thus they are often less than optimal, inefficient, just barely good enough to do the job of ensuring survival. Living systems also possess a huge evolutionary "inertia," the legacy of reliance on conservation and reuse of old, pre-existing methods, components and systems. Evolution creates innovative new approaches only by accident, never by intent or design. As a result, many of the most fundamental characteristics of molecular biological systems were locked in aeons ago and cannot easily be changed.

Evolution does not consider simpler or more elegant solutions, only what works (in terms of survival) at the time. Many options for the structure and function of molecular sys-

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tems have never been explored, many materials never used, many reaction pathways never followed, simply because they have never appeared in any cell to work upon.

Finally, living systems are constructed of materials that are, for many of the purposes to which we would like to put a productive technology, very fragile and unstable. They can't usually tolerate extreme conditions and still function normally. Some research indicates that biological molecules may be coaxed or modified to operate in bizarre environments such as organic solvents,

Table 1: Molecular Biological Analogs of Machine Components*

Device	Function	Molecular Analog
Struts, Beams, Casings	Structural Framework to Support and Transmit Forces; Positional Stability	Microtubules, Cellulose, Cell Walls and Internal "Cytoskeleton"
Cables	Transmit Tension Forces	Collagen, Other Fibrous Proteins
Solenoids, Actuators	Provide Motive Forces	Conformation-Changing Proteins; Actin/Myosin (Muscle) Proteins
Motors	Provide Rotary Motion	Flagellar Motor (Bacteria)
Drive Shafts	Transmit Torque	Bacterial Flagella
Containers	Hold or Isolate Materials, Components	Vesicles, Lysosomes
Pumps	Move Fluids & Small Objects	Trans-Membrane Proteins and Ion Channels; Cilia and Flagella
Drills, Injectors	Piercing, Boring, Insertions	Viral Membrane Penetrators
Clamps, Grippers, Manipulators	Positional Precision and Stability	Binding Sites (Enzymes, Antibodies, Receptors and other molecules)
Tools	Modify Other Objects	Active Sites, Side Groups, Co-Factors in Enzymes/Metallic Complexes
Production Assembly Lines	Break Down Complex Operations; Join Components & Sub-Assemblies	Complex Enzymes; Golgi Apparatus; Ribosomes (Protein Synthesis); Mitochondria (Oxidative Respiration); Chloroplast (Photosynthesis)
Energy Transmitters/ Receivers	Emit/Absorb Radiant Energy; Communications	Chlorophyll; Photosynthetic and Bioluminescent Systems; PhotoSensory Pigments (Rhodopsin)
Information Storage/ Control Systems	Store Programs; Maintain Homeostasis	Genetic System (DNA Based); Associated Transcriptional and Regulatory Proteins

*After Drexler, in *Proceedings of the National Academy of Science, USA*, Vol 78, pp 5275-78 (1981).

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or liquid xenon. But it's much more likely we'll instead learn to build molecular machines out of stronger, more durable materials. The first steps have already been taken.

SYNTHETIC CHEMISTRY

Synthetic chemistry has a long history of accomplishment; humans have been successfully making designated molecules for well over a century now. But much of even modern industrial chemistry is based on bulk techniques, not fine control at the atomic and molecular level. Modern processes often involve long, complicated pathways in which various additions, subtractions and transformations are made, with small steps occurring via circuitous, indirect routes. Reactions are often forced under extreme conditions of temperature, pressure, acidity and other factors. The end result is usually a mixture of products and isomers that must then be separated and purified.

Despite these methods, our knowledge of chemical synthesis is advancing rapidly, and is on much firmer theoretical ground than protein chemistry and engineering. We have a much better grasp of how relatively simple molecules are put together and how they interact with one another and with their environment. And we have become increasingly skilled at creating molecular forms never seen before, that probably have never occurred in nature. Much of this work is still done using traditional bulk methods, but the knowledge gained of synthetic pathways, reaction mechanisms and dynamics—all the myriad aspects of advanced molecular chemistry—will be invaluable when we finally can extend fine control down to the level of individual atoms and molecules.

As with research in biochemistry and protein engineering, exciting lessons are being learned in the design, synthesis and behavior of molecules that may one day serve as components in the assembly of molecular machines. But here the vistas are broader and more open than with biological systems, for we are not limited to the terrestrial evolutionary repertoire, but may make free use of all available elements and compounds to assemble precisely what we need—if it is permitted by the laws of physics and chemistry. They will be the only final limitations.

This means, in theory, that our designs should be simpler, more predictable, more reliable, more stable and durable. We still have a long way to go to achieve this ideal. But significant progress is being made in learning how to design first-generation molecular effectors—elements that will recognize, bind and manipulate other molecules—as well as structural components.

Many natural catalysts, both biological and nonbiological, are built around organometallic complexes, in which an organic skeleton binds one or more atoms of a metal such as iron, copper, zinc, or magnesium. These multi-valent metals often occupy a central position, serving to "coordinate," or maintain various "ligands" and side chains in their proper positions within the complex. Be-

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cause of their known catalytic activity, researchers interested in creating *de novo* molecular designs focused on organometallic systems quite early.

Initially, much of this work was simply trial and error, but as time went on and more detailed knowledge of and experience with their structures and reaction dynamics accumulated, general principles began to emerge. The pace of progress began to increase as a workable theoretical architecture was constructed.

By the early 1980s, important gains had been made in understanding the processes of molecular recognition and binding, and in the purposeful design of functional molecules. The abilities of synthetic chemists to actually produce these complex forms were also making great advances.

Investigators studying how organometallic complexes catalyze chemical rearrangements, transformations and other reactions. discovered that such systems had many similarities to protein-based enzymatic catalysts. But they were often much simpler, even though the reaction mechanism might be quite complicated.

Researchers also learned how to add carefully chosen side-groups in or alongside the "active site" cavity of organometallic catalysts, which enhanced recognition and binding, or catalytic activity—sometimes both. These added side-groups were often chiral, meaning they had a specific, precisely-defined three dimensional shape and orientation, which increased the specificity of the complexes' catalytic activity.

These relatively simple complexes, however, were usually less capable than natural enzymes and, like abzymes, it proved more difficult to design organometallic systems that catalyze *synthetic* reactions; most of those created so far only cleave bonds, not make them. But they often are able to function in environments or under conditions where natural enzymes are sluggish or inactive.

Those working in the field recognized the potential for creating new systems that would be more durable and flexible than biological systems, capable of functioning in non-aqueous environments and performing reactions not normally used or catalyzed in natural systems. In part because the concept of nanotechnology had not yet received much attention, a biological paradigm continued to dominate their thinking. It was thought that organometallic complexes could be combined with membranes and vesicles, forming artificial receptors and catalysts to create chemical "micro-reactors" and artificial cells.

By the mid-'80s studies in the field had become much more detailed, examining much more subtle aspects of molecular shape, behavior, and interaction. The systems being designed and synthesized became more complex. Researchers were now designing artificial receptors and catalysts capable of strong, highly specific recognition and binding of substrates, and then catalyzing reactions and the formation of new chemical structures. Carefully placed side-groups broke bonds in or made additions to

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the target molecules.

The most complex of these artificial forms had multiple binding sites for holding multiple substrates, and were capable of catalyzing complex, multi-step reactions. Others underwent conformational changes, folding inward or outward to bind metal ions and small molecules.

More recently, there have been attempts to create systems that assemble themselves spontaneously, as many biological systems do. So far, there has been some success, ranging from simple coordination complexes to fairly large, complex molecules with twists and turns in their structures that serve as a template for further self-replication, resembling DNA. None of these is a reaction catalyst, but there is optimism that design and synthesis of catalytically active, self-assembling systems may soon be possible.

The importance of this line of research was recognized in 1987, when Charles Pedersen, Donald Cram and Jean-Marie Lehn, three of the leading investigators in this area, were jointly awarded the Nobel prize in chemistry. Their results, along with contributions by many others, have helped illuminate important principles necessary for the creation of *de novo* molecular forms that may eventually lead toward nanotechnology.

This work has helped outline elementary processes and interactions at the molecular level. It has also shown that recognition, binding, and catalysis can be affected by molecular systems that are much smaller and simpler than in living cells, supporting speculation that simple, elegant, efficient molecular machine designs will be possible.

Other areas of synthetic chemistry are also yielding important results that may prove useful in the development of molecular nanotechnology. One of these is the creation of large, complex molecular frameworks and structures with novel compositions and properties; many of them have functional activity as well as structural utility. This is an area of exploding activity, and it remains to be seen how these molecular structures might be used in nanotechnological systems.

Among these are a class of complex synthetic polymers called "starburst dendrimers." These are large, symmetrically branching molecules that resemble spherical trees. They can be "grown" or synthesized beginning with a small core with three or perhaps more attachment points. New components, with three attachment points each, bind to the core, creating six branches (one point is used in binding to the core). Further additions are made and the branching structure grows outward geometrically in a precise, deterministic manner until the expanding network becomes so congested that further growth is inhibited. Often, this dense network forms a membrane-like barrier over the surface of the spherical molecule.

By carefully selecting the core and branch-building components, as well as the conditions under which growth occurs, precise control over the size, shape, chemical properties

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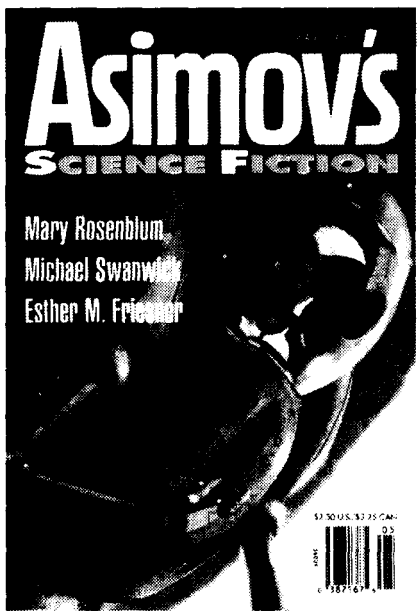

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and branching pattern can be maintained, with extremely uniform results. Molecules expand from a small core to complexes containing tens or hundreds of atoms on up to huge spherical networks the size of whole viruses, containing many thousands of atoms.

Researchers speculate that these branched dendrimers could serve as molecular frameworks for the attachment of receptors, reaction sites and other functional groups—perhaps in patterns forming assembly lines across the surface, or reaching down into the interior branches. The interior spaces could also serve in the sequestering, storage and transport of materials that need to be isolated from the surrounding environment. It has even been suggested that by maintaining a charge separation between a dendrimer's interior and its surface "membrane," it could function as a molecular-scale storage battery.

In another line of research aimed at constructing regular molecular frameworks, investigators have taken a modular approach. While starburst dendrimers are composed of small, relatively simple organic components, these modular systems employ organometallic complexes as building blocks. Several teams are investigating systems in which complexes with regular geometric shapes are designed to fit together, often through spontaneous self-assembly, into orderly patterns and arrays. These systems have been given suggestive labels such as "molecular tinkertoys" or "molecular meccano."

In addition to providing predictable, regular frameworks built up from simple modular components, these systems have other potentially useful properties. Some of these modular arrays exhibit photo-induced electron transport, which might be harnessed to do useful work, or at least provide lessons in creating artificial photosynthetic systems or molecular circuits. Many in the field speculate that by controlling the arrangement and spacing of such components, as well as their chemical and electrical properties, they may eventually be able to create wires, switches and other devices for the construction of molecular-scale computers.

Almost all research into the creation of custom designed molecules employs carbon, at least as a skeleton for the attachment of other atoms, side-chains and functional groups. This follows from our accumulated knowledge of biochemistry and synthetic organic chemistry. Other forms of carbon are also being investigated for their potential use in the construction of molecular machines.

The most important among these is diamond. It has been suggested by Eric Drexler, and others, that mature nanotechnological systems will be constructed of hard, rigid, durable components made essentially of diamond, or "diamondoid" molecules. As yet, we cannot build such structures with the necessary precision, but the structure and properties of diamond and diamond-like molecules are the focus of intense ongoing research that is laying the groundwork

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for such use in the future.

By varying the isotopic composition of diamond, for example, researchers have created crystals with enhanced properties. Diamonds with a lower than natural percentage of carbon-13 conduct heat more readily and resist higher intensities of laser light. Diamonds of nearly pure carbon-13, on the other hand, are more densely packed, and are harder than natural crystals. Other researchers have made theoretical predictions that a carbon-nitrogen hybrid might well exceed the hardness of plain diamond by a large margin.

Another exotic form of carbon that has spurred widespread interest and intense research activity is a class of molecules known as *fullerenes*, more familiarly known as "buckyballs." Some of the unique properties and potential uses of fullerenes are described in the boxed sidebar.

These are just a few examples of research in synthetic chemistry that may enable the development of molecular nanotechnology. There are many, many others. While much research is conducted for purely theo-

"Buckyballs" and Other Fullerenes

Fullerenes are remarkable molecules composed of closed, spherical carbon lattices. one of the most stable is C_{60}, a large structure in which the carbon atoms are arranged in an orderly pattern of hexagons and pentagons, just as they appear on the surface of a soccer ball. This is also the pattern of Buckminster Fuller's famous design for the geodesic dome, which suggested the familiar name for C_{60} among chemists: buckminsterfullerene. It and similar molecules are collectively referred to as fullerenes or, more casually, "buckyballs."

Fullerenes range from irregular closed lattices with 28, 32, 44, and 50 carbon atoms on up to gigantic hollow lattices containing 240, 540, and 960 carbon atoms. These hollow molecular shells are quite stable, due to resonance effects among the carbon bonds forming the shell, which act to stabilize the fullerene's three-dimensional structure in much the same way the six-membered benzene ring is stabilized in two. With their unusual structure and stability, fullerenes exhibit a variety of unique and exotic properties never before observed.

Buckyballs exhibit non-linear optical properties; that is, they transmit light in a variable fashion, depending on the intensity of the incoming light. At high

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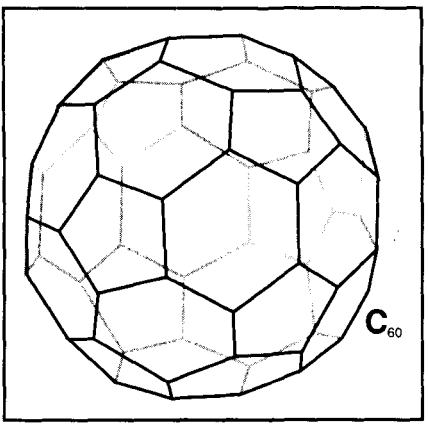
intensities, fullerene solutions become nearly opaque. These properties may prove useful in the design of "optical shields" for eyes and delicate instruments, as well as switches and other elements in optical computers. Fullerenes in sheets and layers exhibit other interesting opto-electronic effects: high-intensity light shining on one side of the sheet induces an electrical voltage potential on the other face. Fullerenes have also shown superconducting activity at very low temperatures. When "doped" with metals such as cesium or rubidium, fullerene sheets exhibit superconductance at temperatures as high as 30 to 45 degrees Kelvin; with iodine, this rises to 57 K.



Other researchers have succeeded in placing metal atoms and ions inside closed fullerine shells, and suggest metal ions inside an inert shell could act as non-reactive charge carriers in batteries and other molecular electronic systems. Larger fullerene shells might serve as enclosed reaction chambers or storage vessels. Nested shells with smaller fullerenes enclosed inside larger ones have also been observed, and could serve for separating different materials or reactions.

In addition to spherical forms, fullerene tubules and cylinders have also been created. These might serve as containers or pipes. Buckytubes of different sizes and structures also behave as conductors and semiconductors, and may play a role in the development of molecular-scale wires and circuits.

It has been suggested that the regular, symmetrical shape of fullerene spheres would provide a nearly ideal tip for Scanning Tunneling (STM) and Atomic Force Microscopes

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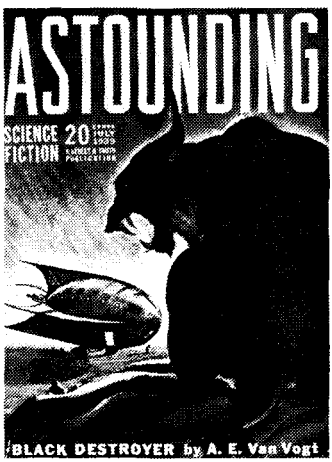

Critics mark this issue as the first "great" issue edited by John W. Campbell, Jr. It contains the first published story, "Black Destroyer," by A.E. van Vogt and the first story by Isaac Asimov to be published in **ASTOUNDING.**

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(ATM). Other research has shown that a 76-carbon form helps nucleate or catalyze the formation of diamondoid structures in molecular devices.

Theoretical calculations predict that fullerene-like sheets could be formed into regular, three-dimensional frameworks of great strength and stability, resembling a playground "jungle gym," which could serve as a sort of scaffolding for molecular-scale devices and systems.

Fullerene research has spurred the creation of other exotic molecules with similar structures. Hybrids combining carbon with titanium, vanadium or zirconium have been synthesized. Completely non-carbon molecules with the characteristic soccer ball structure have been constructed from boron and hydrogen, and tungsten disulfide.

retical or short-term practical purposes, without any intent to design toward molecular machines, the knowledge and experience gained in all these areas will allow for expanded options and capabilities when we do begin to achieve more precise control in the molecular realm.

MACROSCOPIC SYSTEMS

While numerous suggestive advances have been made toward enabling a "bottom up" approach to nanotechnology, they still rely on bulk processes; we do not yet have any systems derived from biology or synthetic chemistry capable of the precise, controlled manipulation of individual atoms and molecules. Surprisingly, this capability *has* been developed, at least in rudimentary form, through a "top down" approach using macroscopic systems on laboratory benchtops.

The most widely used of these devices is the *Scanning Tunneling Microscope*, or STM. Developed in the late 1970s by Gerd Bennig and Heinrich Rohrer at an IBM research lab in Zurich, Switzerland, the key component of the STM is an extremely sharp needle or tip that is brought within a few atomic diameters of a surface; quantum effects allow electrons to "tunnel" across the gap, creating a small but detectable current. As the needle is scanned across the surface its height is continually adjusted to keep the tunneling current constant. These adjustments are used to generate a sort of atomic-scale topographic map of the surface.

The STM was initially used as an imaging device, capable of resolving individual atoms, and this remains its primary use today. This alone was considered an important enough achievement to earn the inventors the Nobel Prize in physics in 1986. Since then, however, the STM has also been used in an increasingly sophisticated manner to manipulate atoms and clusters of atoms.

In 1988, a team led by John Foster

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at another IBM lab in San Jose, California succeeded in using an STM to pin small organic molecules to a graphite surface by applying a small electrical pulse. Additional pulses could enlarge or erase this molecular feature, and often split the organic molecule into smaller pieces, though not in a controlled manner. This experiment was intended to investigate the possibility of creating a readable and writable molecular-scale information storage system, but also demonstrated the STM could be used to manipulate and "edit" small molecules. Other such molecular cleavage experiments have followed.

More precise control was achieved by a second team at the San Jose lab in 1990, when an STM was used to position 35 xenon atoms on a nickel surface to spell out "IBM." This experiment, however, was carried out at near absolute zero; the arrangement was unstable at more normal temperatures. Within a year, in July 1991, another research team had succeeded in moving clusters and single atoms of silicon across a silicon surface at room temperature. Such work may eventually lead to the ability to construct very fine scale quantum electrical components with semiconductor materials.

A major limitation of the STM is that it only works with conducting materials such as metals or semiconductors. But a variation of the device allows for the atomic scale examination of nonconducting materials such as organic and biological molecules. This is the *Atomic Force Microscope*, or AFM.

An AFM works by simply dragging the tip *very* lightly across the target surface, rather than scanning above it. By holding the force of contact constant (rather than a tunneling current), the tip's motions over the surface are again used to generate an image. Although somewhat less sensitive than the STM, the AFM is still capable of resolving individual atoms.

Other variations of the STM and AFM have been created that sense extremely fine variations in friction, magnetic and electrostatic forces, thermal energy and optical absorption, each providing useful images of the atomic and molecular realm at varying resolutions. They are referred to collectively as *proximal probes*. Each is also subject to limitations, imaging flaws and problems of interpretation, due to variations in operation, tip structure and other factors.

STM and AFM tips have been used in dozens of experiments attempting to modify surfaces or manipulate atoms and molecules. They have been employed to scratch, melt, erode, indent or in some other manner alter selected surfaces. Individual atoms, clusters and molecules have been pinned, split, picked up, moved and set down, sometimes with extreme control and precision. But we are still a very long way from using proximal probes to construct complex molecules held together by strong covalent bonds, let alone functional machine components.

We may eventually be able to do so, however. In 1990, Drexler and IBM's John Foster proposed one po-

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tential first step toward creating more capable systems for molecular manipulation. They suggested the use of custom-made, synthetic proteins to be mounted on the point of an STM or AFM tip. Modified antibodies or specially designed proteins could serve as simple, first-generation "grippers" for binding and manipulating chosen molecules, bringing them into position to react with other molecules in a precise, selective manner.

Such a system would be slow and quite clumsy, but it could provide a first step in the development of more sophisticated molecular manipulation and assembly systems. As yet, no attempt has been made to create such a molecular manipulator, but there is no fundamental obstacle to prevent it: the technology of proximal probes and protein engineering are likely to converge to produce a crude first-generation device within the next few years.

Many working on nanotechnology or in related fields feel the advent of such a device will initiate a period of rapid, accelerating activity aimed at developing second and third generation devices, leading eventually to a mature nanotechnology some time in the next century, perhaps in only a decade or two. Others feel the challenge may require more time. In any case, in addition to expanded capabilities in molecular manipulation and chemical synthesis, this scenario assumes the development of our abilities to design and model complex molecular systems—in short, that we will create a new field of molecular engineering.

* * *

ENGINEERING THE FUTURE

The field of molecular engineering as it relates to nanotechnology is still very much undeveloped; it remains largely conceptual, and those pursuing actual research related to developing molecular machines work in a wide variety of disciplines: molecular biology, organic and synthetic chemistry, solid-state physics, materials science and others. But as the relevant knowledge accumulates and enabling technologies are developed, the field of molecular nanotechnology has become more coherent and defined, more directed toward accomplishing real-world goals.

As in any field of engineering, as knowledge and capabilities are developed, so too are new theories and tools for directed design of working systems. This process has already begun in the field of molecular nanotechnology.

Perhaps the most important tools currently being developed are computer systems and software capable of modeling and simulating the behavior of atoms, molecules and their environments. Indeed, because we cannot see and touch them directly, modeling has always been an essential element to our understanding of such small-scale structures and events. Computers will enable us to carry out this modeling and simulation with sufficient sophistication and detail to attempt the creation of molecular machines.

Computer systems aimed at modeling atomic and molecular behavior have undergone extremely rapid de-

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velopment since the mid-1980s or so. Previously, such programs have been quite limited, capable of simulating only small, simple systems in isolation, with few dynamic features.

More recent computer systems are now able to model at least some aspects of dynamically active molecules, including motion, vibrational states, and so on. They often can also simulate at least partial interaction with the surrounding environment, such as a substrate or solvent. Such capabilities have had an enormous impact in aiding our understanding of complex molecular interactions, particularly in biology, where the visualization of form is often the key to understanding function.

Sophisticated computer programs have also been used to simulate the interactions of STM tips and surface atoms, leading to new insights into the nature of these interactions, insights later verified by experiment. Similar modeling efforts have brought new, more subtle understanding of the basic forces involved in friction, surface adsorption, diffusion, and other phenomena.

A related development has been the creation of large databases containing information on molecular structures, surface shapes and behavior, combined with software that can catalog, cross-reference and search through these rapidly growing data stores. Such databases have been used in attempts at *rational drug design:* the creation of tailored molecules shaped for a specific purpose—perhaps binding to a particular cell receptor, perhaps blocking the activity of a bacterial enzyme.

The analytical and predictive capabilities of these computer systems is advancing. One system, developed by a team at the State University of New York at Buffalo, is capable of interpreting data from x-ray crystallography studies to determine molecular structures, taking only hours or days to accomplish what once required months or years of effort. These systems have also assisted in the design of artificial enzymes such as CHZ-1 (discussed above) and the modeling of designs for synthetic organometallic complexes.

These capabilities now allow us to carry out realistic *computer assisted design* (CAD) at the molecular level. In addition to the utility of such systems in basic research, rational drug design, biotechnology, and attempts at creating *de novo* molecular forms, sophisticated molecular modeling software offer new tools for experimental investigation of the possibilities and obstacles we may encounter in our attempts to create molecular machines.

Drexler has termed these attempts to design machine components and systems we cannot yet build "exploratory engineering." We have the basic knowledge in physics, chemistry and the behavior of atoms and molecules, he maintains. We now need to learn how to apply that knowledge toward developing the ability to engineer nanometer-scale structures and devices. While much work needs to be done to increase the accuracy and capabilities of modeling and simulation programs, exploratory engi-

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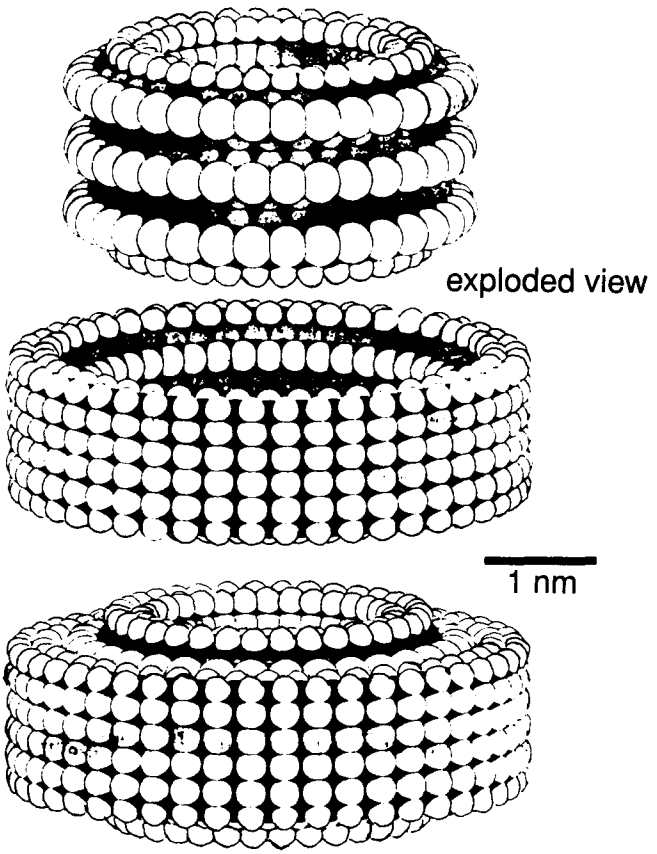
Figure 1: Design for a Molecular Sleeve Bearing



This design, developed by Eric Drexler and Ralph Merkle of Xerox PARC, is shown in exploded view (upper) and with the shaft set into the sleeve (lower). Constructed from modified diamond shells, the shaft and the sleeve together contain 2808 atoms. The shaft sits within an interlocking grooved interface inside the sleeve. The entire assembly has a diameter of approximately 4.5 nanometers.

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neering has already yielded impressive results.

In late 1992, Drexler published *Nanosystems*, a book-length technical treatment of the basic principles of atomic and molecular behavior applied to the problems of molecular nanotechnology. Much of the book, the product of four and a half years of research, presents the results of numerous exploratory engineering efforts conducted by Drexler, often in collaboration with Dr. Ralph Merkle of the Xerox Palo Alto Research Center, and by others.

Drexler, Merkle and the others have designed and modeled a host of complex, molecular-scale machine components such as rods, struts, shafts, gears and bearings, and tools for binding and positioning atoms and molecules. They have also created conceptual designs for motors, pumps, cooling networks and other multi-component systems. According to Drexler and other proponents of molecular nanotechnology, our current best knowledge of and ability to model molecular behavior indicates these parts and assemblies should work as designed—if we could only build them.

An example of these exploratory designs is the molecular-scale bearing shown in Figure 1. The basic structure of both the shaft and its sleeve is a sheet of modified diamond bent into a cylindrical form. The bearing would have to be constructed as a single unit, because the interlocking grooved interface prevents the shaft from sliding into or out of the sleeve.

Critics of Drexler and others who are attempting advanced designs maintain that these complex structures cannot be built, or that if they are, they will not function as predicted. Only time, and a great deal of further research in a wide variety of scientific disciplines, will show whether these early efforts to design molecular machines are correct.

But advances taking place along the lines mentioned here and in many other fields all seem to be converging toward the development of a rudimentary, first-generation molecular technology within the next decade or two. Just how far further development of nanotechnology might take us toward the sort of precise, durable, functionally sophisticated molecular machines envisioned by Eric Drexler and others is uncertain.

Some feel there will be limits and obstacles that will prevent realization of a full-blown molecular technology; others maintain we are on the verge of a technological revolution that will dwarf everything the human race has accomplished up to this time. It depends, in the end, on how well we are able to learn the art of working molecules. ■

ABOUT THE AUTHOR

Richard Terra is a freelance writer and journalist, and holds degrees in both biology and communications. He has written widely on the future of science and technology, ranging from optical computing, to space exploration and

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settlement, to nanotechnology. He has previously worked in medical education and the biotechnology industry, and is currently an analyst and information specialist with the regional urban planning agency in Boise, Idaho.

Many details of the research covered here were presented at the first Foresight General Conference on Nanotechnology held in Palo Alto in November 1992. The author wishes to acknowledge the leading role of the Foresight Institute in encouraging thoughtful consideration of the consequences of technological advances, particularly in the field of nanotechnology. Those interested in finding out more on the topic can contact the Institute at P.O. Box 61058, Palo Alto, California 94306.

THE 1992 ANALYTICAL LABORATORY

Photo credit: Jane Jewell

Left to right: Stanley Schmidt, Jeffery D. Kooistra, Chris Haas-Heye, Tina Lee, and G. David Nordley.

Jeffery Kooistra, author of "Love, Dad," won for best Short Story, and G. David Nordley's "Poles Apart," winner in the best Novella/Novelette category, were both presented with their prizes at a breakfast party held in New Orleans, LA over the Nebula Awards weekend.

Unfortunately Geoffrey A. Landis, who won for best Fact Article with his "Demon Under Hawaii," and Bob Eggleton, whose July 1992 cover placed first, were unable to attend.

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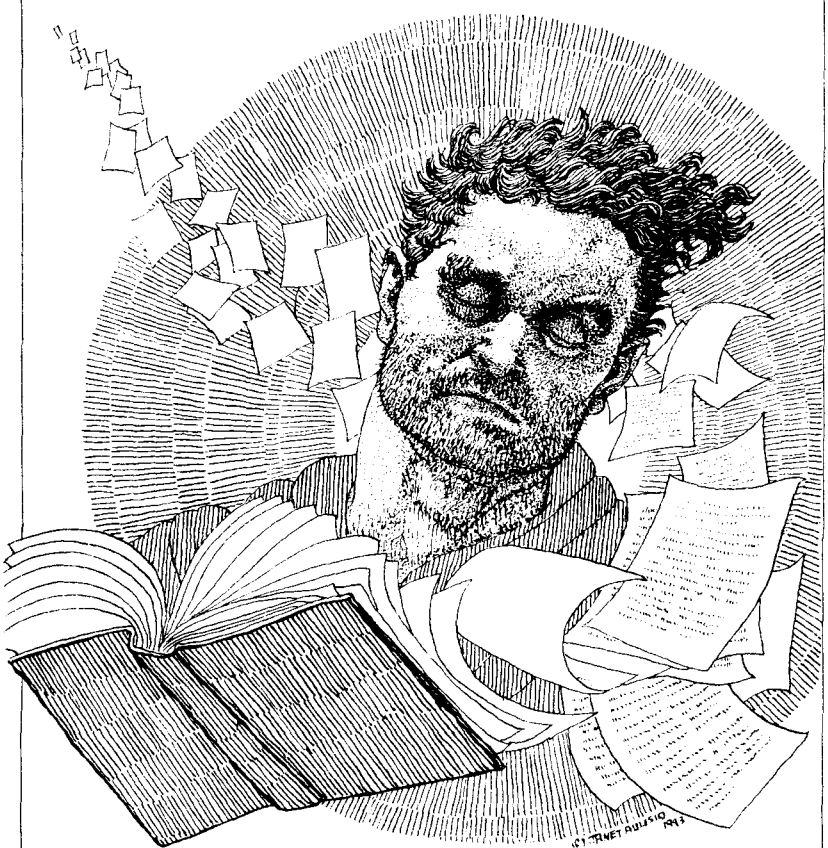
Jerry Oltion

DEDICATION

Any new technology lets people do things they've never been able to do before—some of which, along with the prices, can be decidedly strange. . . .

Illustration by Janet Aulisio



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Keith Hollister smiled as he thought the last line of his latest epic novel into the computer. It was a good book. In fact, it was a great book. It was very likely the best book he would ever write, which was a realization that would ordinarily make a person feel a bit depressed about the future. But this novel was so brilliant that Keith realized he could coast the rest of his life with never a pang of regret simply knowing he had once been great enough to create it.

"My God," he said aloud, "I could die happy right now."

The walls of his study—lined with print copies of his earlier works—absorbed his voice. Gina, his companion for the last year or so, would be curled up on the love seat in the living room, watching the 3-vee or plugged into the memnets, blissfully unaware of the rush he felt.

He pulled the thinkies loose from his forehead and temples, and scratched the contact points while he considered his next move. Normally with a finished manuscript he would play it through again from beginning to end, making one final edit before he sent it to his publisher, but this time he knew better. There were undoubtedly a few rough edges, but now, with this piece, those unpolished spots would only enhance the story, contribute to the breathless effect he'd managed to sustain for most of the book. If he even *looked* at it again, he would be tempted to tinker, and any changes would only ruin it. Everything had been crafted to have the maximum effect on a person playing it or reading it for the first time, and that made him the last person in the world who should alter it now.

He couldn't *know*, of course, if he'd succeeded. The story in his head might not have made it onto the screen as well as he thought it had. He wouldn't be able to spot that sort of problem, because the story *was* in his head, and he would automatically fill in the blanks as he read. It was a problem every writer faced. He could always put it aside for a month or two until the memory of it had faded a little in his mind, but he doubted if that would do much good. This story was so brilliant, so electrifying, that the moment he picked it up again the whole thing would come flooding back.

No, he'd better just send it off to his editor and be done with it. He could do that right now, just as soon as he gave it a dedication. Keith put on the thinkies again, stretched a new page into existence at the beginning of the manuscript, and leaned back to consider who it should go to. Gina? They'd only been together a year, but she'd been with him through most of the writing of the book. He'd always assumed he would dedicate it to her, and he supposed she did too, but that was before he knew this was his masterpiece. He loved her, sure, but he'd loved lots of people in the 135 years he'd been alive.

I could die happy, he thought. Who should he dedicate something this significant to?

He woke to the antiseptic smell of a hospital recovery room. Other aromas filled his sinuses as well; plas-

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tic and paper and cotton sheets fresh from the laundry, someone's faint body odor, and a million more subtle fragrances. He was in a new clone, then. His sense of smell hadn't been this good in decades.

He blinked his eyes open and saw a nurse frowning as she lifted the oversized thinkies of a portable doc away from his forehead. She was a big, dark-skinned woman with a no-nonsense stance, but her frown twisted into a smile the moment she realized he was awake.

"How do you feel, Mr. Hollister?" she asked.

"OK," he said. "A little disoriented. I remember coming in for a routine memory recording, but I don't remember scheduling a rejuvenation with it, so I assume there's been some sort of accident."

She nodded. "You're right. And the latest personality backup we could find for you was the one you remember, but that was nearly a year out of date. That plus the ten months it took us to force-grow a clone for you means you're almost two years behind. You really should back up your system more often."

Keith reached out and grasped the bed's chrome rails and pulled himself upright. It took considerably less effort than it would have before. "You're right," he said. "I'm always thinking I'll do it, but I get sidetracked and forget. You know how it goes."

"Hooo, don't I just?" The nurse shook her head as she wrapped the doc's comlink cord around the headpiece and tucked it into a niche on top of a cart full of electronic components. "Well, you're better off than some people. Had one in here the other day whose last backup was ten years old. Ten years! He didn't even remember his kids. Lost his job, too. At least you haven't changed professions."

Keith snorted. "I might as well have. God. Two years. That's forever in the writing business. Nobody'll remember me."

"There's where you're wrong," said the nurse. "You feeling strong enough to use a phone?"

"I guess so. Why?"

The nurse reached up to the phone screen suspended on a long arm from the ceiling and pulled it down toward his lap. "Because you've already got three calls."

"Oh." He tilted the screen so he could see it comfortably, but paused before he switched it on. "By the way, what happened to me, anyway?"

The nurse gave him a searching stare. "I guess you wouldn't know that, not as far back as you are. I normally don't tell people when they do what you did, but this time I guess it ain't going to matter much. The chance of your doing it again is pretty small."

"What, you make it sound like I killed myself."

She nodded. "That's right. Half a bottle of sleepers."

After the nurse left, he sat there staring at the blank phone screen and wondering why he might have killed himself. Bad reviews? Had he gotten into some kind of trouble with a

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woman? It had to be something like that, something he'd wanted to forget about, otherwise he would have made a more recent backup before he did himself in.

Maybe his calls would explain something. He flipped on the phone and played them.

The first was a newsfaxer from the *Global Enquirer,* offering ten million dollars for exclusive rights to his story. It took Keith a moment to realize the guy meant the story of why he'd killed himself, rather than a piece of fiction he'd written. He told the phone to save that one for future reference. He didn't want to deal with a scandal screen unless he had to, but ten million could at least keep him afloat for a few months. He might have some hefty bills after two years out of circulation.

The next call was his agent. Her blue eyes didn't quite focus on him, but her stern expression still came through. "Don't accept any offers until we've had a chance to talk," she said. "I assume you still remember my number."

The third call was from a thin, dark-haired, green-eyed woman he remembered from a couple of publishers' parties. Ginger? Gina? That seemed right. "Well, look who's back," she said, her scowl and her tone of voice nearly blistering the screen. "I don't even know if you remember me, but I just wanted to let you know I've been living in your place. I figured you owed me at least a couple years' free rent for dumping me like that. Don't worry, I didn't trash it, though I probably should have. I'm packing my stuff and I'll be gone before you're out of the hospital. I'm not leaving a forwarding address, and if you try to find me I'll get a restraining order put on you so fast it'll make your heart stop. Again. Have a nice life, deado." She stuck out her tongue at him and then vanished.

Wonderful. He'd evidently been living with her when he'd . . . made his mistake. He tried to recall any passion he might have felt for her, but it simply wasn't there. The body was brand new and the memories in it were too old. No wonder she was mad; he'd robbed part of her life, too.

Or had he? With his dispassionate viewpoint it occurred to him that she might have poisoned him in order to get the use of his place while he was gone. Or maybe she was mad at him for something else and she'd wiped him for revenge.

Or maybe she hadn't had anything to do with it at all. Whatever the reason, she hadn't left him many options for pursuing it, or even for patching things up with her.

So he returned the call from his agent, though he wasn't exactly eager to hear what Freida had to tell him, either. "Let me guess," he said when her image filled the screen. "My latest book must have bombed worse than World War Three."

"What are you talking about?" she asked, genuinely puzzled. "It's a sensation! It saturated the net in a month, and it sold five million printed copies in the first year. The few critics who've got courage to even talk about it are calling it the best book in a decade."

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"*Descanting Descartes* did that?"

"What?" Frieda narrowed her eyes, then comprehension widened them again. "Oh, that. D.D.'s selling OK too, now, but I'm talking about *Mining the Maelstrom.* Your magnum opus. It's the hottest thing since cold fusion."

Keith shook his head. "I hate to disappoint you, but I don't remember it at all. What's it about?"

Her face went through a kaleidoscope of expressions. Amusement finally won out, and through her smile she said, "I think you may be the only person on the planet who doesn't know."

"So tell me!"

"Ha! Are you kidding? And rob you of the pleasure of reading it for the first time? Forget it. This is the opportunity of a lifetime. You want my advice, you call up a copy right now and play it before some idiot tells you the plot and spoils it for you."

Keith leaned back in the hospital bed and considered Freida's suggestion. It touched his sense of humor to think that he'd inadvertently found a way to read one of his own books for the first time.

A cold shiver suddenly ran through him. Maybe it wasn't inadvertent at all. Maybe this was why he'd done it. Maybe he'd wanted to know for sure how it would hit a new reader.

"I'll, uh, I'll do that," he said.

Freida nodded. "Call me when you're done. We've got some contracts to discuss." She reached up to the screen and winked out.

Slowly, with a rising sense of dread, Keith dialed up the Carnegie Booknet from memory and downloaded a copy of his novel. Then, using the phone screen for a reader, he fluffed up his pillow, leaned back, and pressed the page advance button.

The cover animation wasn't bad: a surrealistic, almost paisley interpretation of chaos, blending gently into order near a miner in a hard hat swinging a pickax into the confusion. Keith's name was actually in bigger type than the title.

He pressed the page advance again, saw the copyright information and goggled a moment at the date, then pressed the advance again.

The dedication leaped out at him: "To Keith. This one's for you."

There didn't seem to be much doubt anymore. He thought of the two years missing from his life, of Gina storming away in anger, of the other friends who would have simply drifted away by now.

He flipped to the first page, thinking, *This had better be worth it.* ■

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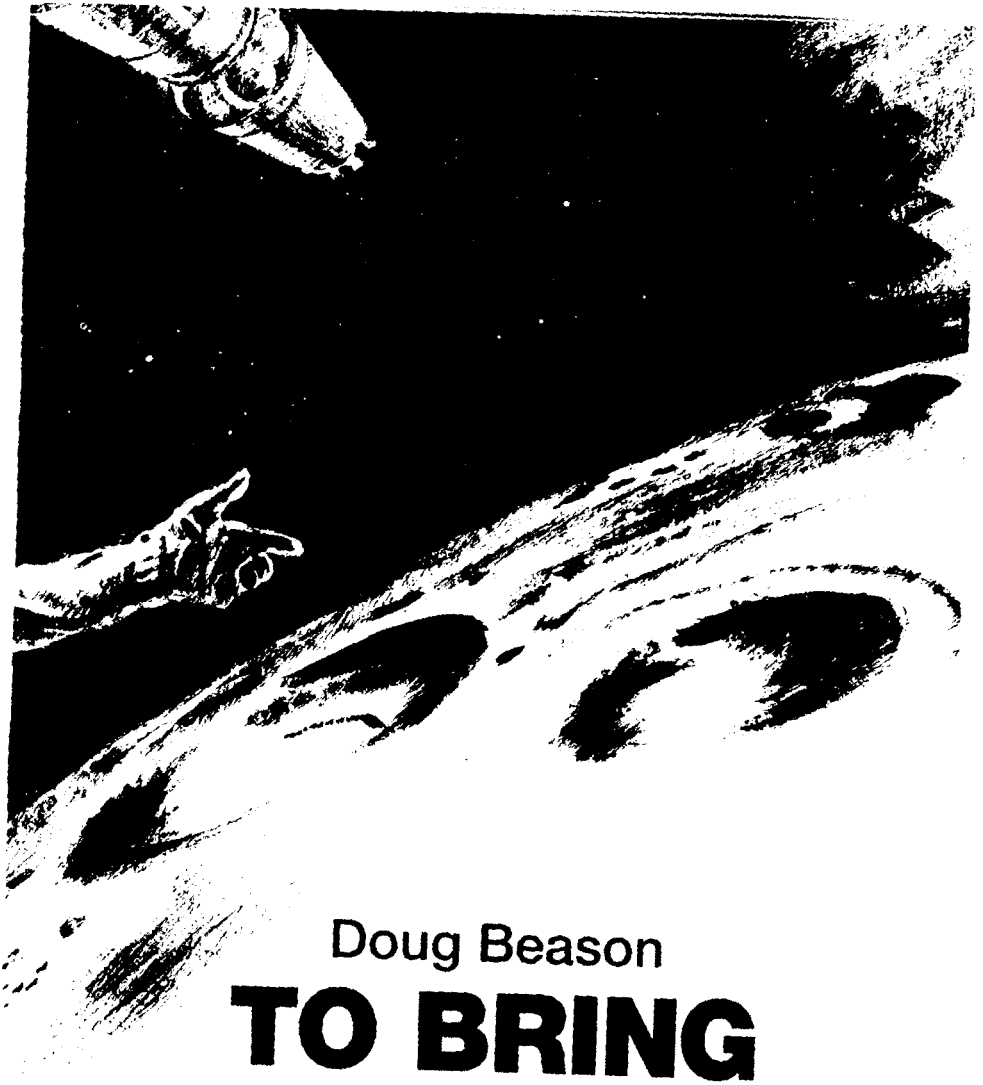

Doug Beason

TO BRING *DOWN* THE STEEL

When you're tied up in 'nots'. . . .

Illustration by Vincent Di Fate

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No one ever said it was going to be easy. But then again, MiningCorp had not yet floated a megaton asteroid to Earth—only a hollow aluminum sphere, ten meters in diameter—so they *thought* it was possible. Theoretically. And that was the whole point.

That's why they called me in—Stu Mendez: forty-two, space construction boss, independent contractor . . . and overreactive as hell. Ever since the government pulled off the Moon and left the Helium-3 factory—built by yours truly—floundering on the lunar surface, I didn't give a rat's derriere about taking chances. And that's why D.K. at MiningCorp hired me on.

Three asteroids, each just over two kilometers in diameter, orbited the Earth, out far enough so that even in a couple of millennia their orbits wouldn't decay. Two additional near-Earth asteroids were on their way in, rockets on their surfaces gently making the critical course corrections necessary to insert them into Earth orbit. An A.U. away, four other "near-Earth asteroids" were being readied to make the trip.

There were enough raw materials in the carbonaceous asteroids to supply the Earth with precious minerals for the next twenty years. And with the anticipated glut on the market, the price would drop far enough so even the Third World countries could afford it. Ever since MiningCorp had made the initial investment, they were getting ready to recoup their losses, cash in their chips and start raking in the big bucks; their profit would come from pure quantity of sale.

As it turned out, the easy part was kicking the asteroids into near-Earth orbit by strapping on some nuclear thermal rockets and diverting the rock's trajectory. The really touchy part was getting the asteroids *down* to Earth—down the gravity well, where good old time-tested manufacturing techniques could be used to exploit all this raw material.

You see, MiningCorp was speculative, but not stupid. They knew that they would break the bank if they started building metallurgy factories in space. It just cost too much money to send that stuff up into orbit, take care of the hundreds of people doing the mining, processing and manufacturing, and then bring the finished products down to Earth.

It was about as bright as building a light bulb factory in space to take advantage of the vacuum. A revolutionary idea, but not too intelligent. Or cost effective.

So MiningCorp knew from Day One that there was going to be a problem getting the asteroids down to the Sahara Desert, down where it made sense to actually mine those suckers. The only problem was that landing a few megatons of rock without slowing it down was just plain crazy.

MiningCorp was after a profit, but they didn't want to slam the world into a new Cretaceous period—wiping out thousands of species wasn't their idea of being faithful to their stockholders.

And to make it profitable they had

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to bring down *megatons* of the stuff, not just the small amount they could cram in a freighter, even making several rocket flights a day.

You see, to the physicists who dreamed up kicking the asteroids into orbit around the Earth, mining the material was simply an engineering problem. That's right, simple. Just like parting the Red Sea was an engineering problem to Moses.

So now that these asteroids were orbiting Earth, we desperately needed a way to bring them down without wiping out life as we know it.

The best way to bring them down surfaced in an exotic think-tank in Northern California known as O-Division. The wizards there came up with "The Plan." And when O-Division contacted MiningCorp, the engineers couldn't find anything wrong with The Plan. They knew it was possible, even though it sounded crazy as all get out.

So who did that leave them to pull it off?

Someone who didn't give a damn about the rules and would bull right ahead to pull it off.

Me.

The asteroid didn't look as big as I thought it would as we approached. Maybe it was Earth hanging in the background, its blue-green expanse filling most of the black sky that made the asteroid look that small.

Craters, jagged edges and seared rock surfaces slowly rotated in and out of view as sunlight glinted off the surface. I couldn't see any rubble—there wasn't enough gravity to hold any down.

It was one thing to see the asteroid in a holo, but quite another experience to be up close and personal. It's kind of like the difference between seeing the Matterhorn at Disneyland and climbing the real thing in Switzerland.

The retrorockets slowed us to where the ship hung not more than twenty kilometers away. It was eerie, rendezvousing with this relic from the past.

The gang pushed toward the airlock and waited patiently in line for the lock to cycle. They passed their time listening to news of the riots in the Saharan Hegemony; although it wouldn't stop us from sending down the asteroid, it still bothered me.

The cargo door opened on the other side of the ship. The motion of the giant hatch sent vibrations throughout the ship. As we queued up to go outside, I waited until last, making sure that everyone's suit was double checked.

I pushed out into space. Brilliant pinpoints of stars stood out against the dark blanket of night. Earth was above me and the asteroid was at my feet. Two spacesuited crewmen drifted around the cargo door and started poking through the insulated bay area. I squinted but couldn't make out the names on their suits. Next time I'm going to insist we color-code the suits; it would make it a lot easier to tell who I was talking to out here.

I bumped my mike with my chin. "Andrews, Cranmer—is that you in the bay?"

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"Roger, Stu. Looks like the gear made it all right. Everything's still in one piece."

"All right then, quit screwing around and pull the FEL on out of the cargo bay. MiningCorp's not paying us to goof off."

"Roger."

The Free Electron Laser took up only a small part of the hold; the rest of the volume was filled with grapples, commcable, venting hardware, and the retroengines. The LOX and LH2 for the retroengines were coming up on the next cargo flight, rendezvousing with us if everything went well. We didn't want a few metric tons of liquid oxygen and hydrogen lying around if we didn't need it. Even with graphite composite storage tanks, we couldn't afford the leakage rate since we needed to squeeze every erg of energy out of the engines.

The gang swarmed over the FEL once Andrews and Cranmer wrestled it from the hold. They unfolded the beam accelerator and telescoped it out to a full hundred meters, running it right up to the superconducting wriggler magnets that would eventually divert the electron beam to produce the laser radiation. It took a couple of hours, but once put together, the FEL was half as long as the cargo ship.

While the gang assembled the FEL I jetted on over to the rock. It wasn't until I was within a couple of kilometers of the asteroid that I finally began to appreciate the size of the thing. It absolutely dwarfed the ship; it was humbling to approach the monstrosity.

I slowed down and watched the asteroid slowly rotate in front of me. At the top I could make out the small crater where the nuclear reactor had been placed, to power the engines that kicked it into Earth orbit. The reactor was gone, of course, since it would still have been spewing neutrons—I imagine they had shot it into one of those hyperbolic orbits so we wouldn't ever have to worry about it again.

Satisfied, I rotated and shot a burst of gas to hurl me back to the ship. With everything in place, it was time to rap and rally.

The Free Electron Laser had diagnostics that used spectrographic backscatter to analyze exactly what type of material it was cutting through. The asteroids should be pretty much homogeneous, but it made things one heck of a lot more efficient to be able to variably tune the FEL to the exact resonance of the molecular constituents.

Once the FEL was locked into place, it started carving up the carbonaceous rock like a sword swishing through air. I couldn't see the laser beam since there wasn't an atmosphere for the light to scatter off.

As the FEL sliced through rock, tiny thrusters coupled with the nav system slowly moved the FEL around. Carving the asteroid into a near-perfect sphere was simply a matter of cutting off everything that didn't belong. Not as hard as the Moses thing, but still a formidable chore.

There wasn't any external force to cause the pieces to move apart, so

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each piece stayed where it was cut. Every half hour I stopped the cutting and sent out a crew to remove the excess rubble. We had a near-miss when Andrews inadvertently shoved a piece toward the ship, but Cranmer sped out to nudge the rock away. Slowly, the one kilometer radius sphere began to take shape.

We finished in ten hours. Most of that time was taken up by getting the FEL aligned.

Finally, a two kilometer diameter sphere of solid rock floated out in front of us. The interferometry showed it was symmetric to within a fraction of a millimeter. I felt confident that we could go on to the next step: cutting the sphere in half, carving out the middle, and then welding the two hollow hemispheres together to make a vacuum-tight vessel.

It still seemed a crazy way to bring the asteroid down to Earth, but once the fifteen centimeter thick hemispherical shells were welded together, all the theory said it was possible. Oh, we still had to install the venting valve, retrojets, and ablation shielding, but that was just adding icing to the cake. When the hollow sphere was sealed up tight, it was just a humongous vacuum chamber. And once we fired the retrorockets to slow the sphere down, it would skip into the atmosphere and start aerobraking—with the carbon-carbon coating ablating excess heat.

A voice came over my headphones just as I was about to join the gang. Ling Matsibiza, the pilot on this bucket, was the only person who hadn't joined us outside.

"Hey, boss. MiningCorp needs to talk with you."

I bumped my chin mike. "Tell them I'll call them back. We're about to cut the rock in half."

"They want you now. They say it can't wait."

"Then run it through the link. I can't keep the gang waiting on a social call."

Silence. Then, "Uh, you'd better come on in. D.K. wants a face-to-face. Company-private."

I started for the ship and didn't bother to argue anymore. These type of calls came in coded. D.K.—MiningCorp's founder, owner and CEO—wouldn't make a company-private call unless it affected something really big. Like profits. I fumed; sometimes D.K. was as bad as the government. I clicked my mike. "Andrews, Cranmer, keep things going. Just be careful."

Without waiting for an answer I rocketed to the ship. Cycling through the airlock, I pushed to the videocom chamber—which was kind of difficult in a spacesuit. Those sleek, one material spacesuit weaves that they show on the holo don't have anything to do with reality. It was *tough* maneuvering around in the bulky suits, and we usually didn't wear them inside except in the ready room, prepping for an EVA. But I wasn't about to spend thirty minutes getting out of the suit for a video call.

Ling Matsibiza hooked me up and swam from the videocom, allowing me to make the call alone. A dot in the center of the screen dilated, growing to show the inside of the

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MiningCorp board room. The room was covered in dark paneling; pictures of commercial spacecraft hung on the walls, D.K.'s legacy. Only three people were present, and it didn't give me a good feeling to note that besides D.K., I didn't recognize the other two in the room—a serious looking man and young woman seated behind a long, immaculately polished wooden table.

I wondered if they were government types, pressuring D.K. to call off the drop. With the growing publicity we'd been getting the past few months, the government might be ready to close down MiningCorp. That's the whole reason we'd spent months negotiating with the Saharan states, to find a place to land the asteroid where they'd appreciate having a few megatons of raw material for industrialization.

D.K. nodded and started talking right off, without introducing his companions. "Stu, we've got a little problem down here."

My face sank. "Are we calling off the drop?"

It took D.K. a few seconds to answer. I could see his jaw muscles working overtime as he considered his reply. This wasn't like D.K., *entrepreneur extraordinaire*. I was lucky to be his lead man—"co-conspirator," as he referred to me. Everything was on a first name basis with D.K., and the self-made billionaire made everyone at MiningCorp feel like they were part of the same big happy family.

D.K. had started out in the space business years ago, always pushing the leading edge of technology. It turned out that his financial talent wasn't so much in identifying the up-and-coming industries that made his wealth, but rather his uncanny knack for getting *out* of that industry, right after he had made his largest profit.

A sudden chill ran through me. What if D.K. was dumping MiningCorp right before the company's biggest coup? Where would that leave me?

D.K.'s voice came strong through the link. "Stu, I've got MiningCorp's legal counsel with me, Julie Lattenbach. Mr. Felton," he nodded to the grave looking man on his right, "is from the State Department."

Uh, oh, I thought. This was definitely serious. D.K. would never bring in the government unless something big was up. And most importantly, I didn't miss the "Mister" when D.K. introduced Felton. Whatever was up, D.K. wanted me to play it "close hold."

I nodded curtly. "Julie, *Mr.* Felton."

D.K. seemed to relax imperceptibly; he must have known I'd gotten the message about Felton. "Stu, there's a contractual problem with the Saharan Hegemony on our landing rights."

"I heard they're having riots, but I thought it would blow over."

"They'll still allow us to land, but they've increased their asking price by a factor of ten."

I kept my face emotionless. Why the heck would D.K. bother me with this? It's not engineering; this is all beancounter stuff, details for the lawyers and accountants to work out. Something's got to be wrong for D.K.

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to want me to hear this.

Julie Lattenbach spoke up. "They've also increased their share of the mining royalties by 100 percent."

D.K. set his mouth. "It's extortion, Stu. The Saharans are insisting that if we're going to land the asteroid in their back yard, then we're going to pay through the nose for it."

"Can they do that?"

Felton, the man from State, cleared his throat. "Precedents have been set before: nationalizing petroleum refineries, for example. We have no reason to believe that the courts won't uphold this."

I could feel my blood pressure start to rise. "Can they really do that? I mean, the rock isn't even there! How can they nationalize something that doesn't exist?"

D.K. shook his head. "They haven't nationalized anything yet, Stu. All they've done is increase their share of the royalties. But that isn't what I've called you about. Mr. Felton is in charge of the environmental ramifications of landing the rock."

Good, I thought. *He's getting to the point.* Now I knew D.K. wanted me to read between the lines. The only reason why MiningCorp had to land the rock in the Sahara was because of the stranglehold put on us by the U.S. government. MiningCorp couldn't flush a toilet without filing for a permit anymore. And now the State Department was playing watchdog, making sure we crossed all of our "i's" and dotted our "t's." Whatever the heck D.K. was getting at, I wanted to get back outside with my gang.

Felton cleared his throat again. "The State Department is keenly aware of the economic impact this demand by the Saharan Hegemony places on your company profits. We don't want this to set a precedent for future commercial activities."

"You mean you want us to make sure the Saharan Hegemony doesn't screw us in the future."

"In a crude way, yes—"

"Then why don't you allow us to land the rock in Nevada, or White Sands?" I asked. "It would be a hell of a lot easier to mine the asteroid in American territory. We wouldn't have to plow all that money into another country's economy, and we would help our GNP instead. It would also keep the State Department out of this mess."

"I've been over this with MiningCorp before. You may not be aware of all the legislation that's paralyzing the mining industry, but it's not just for space-based operations. It affects everything from minerals, oil, gas, precious metals—and that's just for the mining industry; it also impacts the clothing industry, the arts, the sciences, you name it.

"The past decade has spawned so many contradictory laws in our country that it's hard to do *anything.* It even takes two years and the approval of sixteen separate operating agencies just to get a surveying permit." The veins in Felton's neck stood out. He stopped for a breath, and I decided to interrupt before everyone lost track of what we had set out to do.

I said, "All right, I'm sorry. It sounds as if you're just as frustrated

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as MiningCorp. Let's try and get this over with. So why should that concern the State Department, and what do you want me to do?"

D.K. nodded sagely while staring at me.

Felton set his mouth. "Quite frankly, I've been instructed to relay to you that when you crash the asteroid, you should do so directly on top of the Saharan Hegemony capital. We need to show these people that our government means business. Particularly in light of these sudden demands by the Saharan Hegemony that might be interpreted as extortion."

"*Crash?* We're not going to crash the asteroid, Mr. Felton."

The man looked puzzled. "But as I understand it, you are going to smash a megaton of rock in the Sahara Desert, right?"

I cocked an eye at him. "Has anyone outside of State explained the process to you, Mr. Felton? Spent any time going over what is really going to happen?"

"Well, not really. . . ."

"I didn't think so. Let me give you an overview, so we can clear up any misconceptions right now. OK?"

He nodded, stiffly.

I said, "Good. After we've completed making the hollow sphere, we're going to coat it with an ablative shield—carbon-carbon, by running a coating robot over the surface—then strap on some retroengines and fuel tanks. Once we're satisfied that it is sealed tight, we're going to set those engines off. When the retrorockets slow the sphere down enough so it aerobrakes in the atmosphere, it will fall, ablating material.

"As it drops into the atmosphere, the air pressure around it will start increasing—the force per unit area acting on the sphere will get larger and larger as it falls to the ground. And by the way, we're placing the fuel tanks where they'll be shielded from the reentry, so we'll have directional control to steer it.

"Now remember that there's a vacuum inside the sphere—it's hollow. So as the asteroid drops lower, there's going to be a point—and we've calculated this out to several decimal points—where the total air pressure outside of the sphere is going to be greater than the weight of the sphere. It's just the buoyancy force, like taking an empty ball, putting it in water and watching it float."

Felton's eyes seemed to glaze over. "And your empty ball of asteroid material will . . . *float* in the atmosphere, not crash."

"You got it," I said. "Just like that ten meter steel test sphere we floated down last month. The rock will float a little lower of course, but as long as we keep away from the mountains, we'll be OK. We've built a 40 percent safety margin into the design."

Felton screwed up his face. "It just doesn't seem possible—even if it floats, the air pressure should cave in the sphere or something."

"Material strength. The sides are fifteen centimeters thick, and a sphere is the toughest shape to implode: ever try to crush a near-spherical egg?"

Felton still didn't look convinced, but finally he brightened. "That's

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even better! Floating down the rock would cause much less damage than simply dropping it." He cleared his throat, as if his problems were suddenly solved. "The government is asking you—I mean, *ordering* you—to float this over the Saharan capital."

I must have looked shocked, because Felton narrowed his eyes and chided, "Come now. Just because the United States is so tied up in mindless laws, regulations, statutes, rules, and litigation that we can't function, doesn't mean that we can't continue to look after our own interests. We might not be able to change our laws, but we can sure as hell ensure that our economy doesn't get any worse because of it. It's a necessity of life."

"So you're saying—"

"So I'm *ordering* you to station that megaton of floating rock directly above the Saharan Hegemony capital, and force them to abide by MiningCorp's original agreements." He shook a sheaf of papers at the videolink. "The government realizes that our nation's industry needs the minerals in that asteroid. We may not be able to mine it on our territory, so we'll do the next best thing: ensure that it gets mined somewhere else. There is just too much at stake, too much for us to lose by giving in to these demands. If you can force this issue, there is everything to gain. But if you refuse, State will make certain your company never does any business again."

Felton looked flushed, even over the distance at which his image was being transmitted.

This was crazy—we'd be just as bad as the Saharan Hegemony if we did this. *Worse!* I looked to D.K. He raised an eyebrow but was otherwise expressionless. Julie Lattenbach remained mute. *Why isn't anyone saying anything?* Do they agree with Felton, or . . .

Or was D.K. wanting me to read something into this? I remembered why D.K. had hired me in the first place—because I wasn't afraid to do what was right. I didn't hesitate with the mining project on the Moon, and I wasn't about to hesitate now. I decided right then and there to get back with D.K. once this clown from State had left.

So I shrugged. "OK, but why me?"

"You have a reputation of shooting from the hip, Mr. Mendez. This shouldn't be out of character for you at all—we've studied your personality profile." He stopped, then continued dryly, "In fact, the government still feels the repercussions from your Helium-3 strike, and the effect that it had on the fusion industry. I can point to a volume of restrictive legislation directly attributable to your actions."

If I was on Earth, I'd strangle the guy. But for now, there wasn't much more I could do. I forced out the next words. "OK, so I'll do what you want. Now, do you mind if I get back to the gang?"

Felton looked from side to side, but didn't get an expression from either D.K. or Julie, so he turned back to me. He said, "You understand our position?" The question came as a statement.

Boy, do I, I thought.

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"I'm glad we had the opportunity to have this little discussion. I'm sure your company will come through . . . and I'm sure you understand the difficulty our country has in pushing anything through the system. I just wish there was an easy way for us to solve our litigation problem," he laughed, "as easy as threatening the Saharan Hegemony with a megaton of rock."

He hesitated, then raised a finger. "And speaking of that, I'm afraid the government will have to tap into your company's space communications, now that you're contributing to national policy. We have to be certain of your intentions. And if you scramble your transmissions to try to get around us, to forewarn anyone of what you're going to do, we have cryptological methods designed to break *any* secure communications."

Julie Lattenbach stood and slapped the desk. "Now wait just one minute—"

D.K. stopped her with an extended hand. "Julie, that's quite all right. I think we can abide by the State Department's orders. And I don't think it will hinder our effort . . . or our *ultimate* goal of being able to mine the rock. Don't you agree, Stu?"

I got a sudden feeling that there was a deep undercurrent of mission woven in those words: D.K. wanted me to do something, and he sure as heck couldn't say what it was, especially if our scrambled company-private links were now being tapped. It seemed like I was swimming in layers of hidden agendas, all depending on my reputation for acting as a wildcard.

I wish I knew where D.K. was coming from; the way that State had presented their case, things didn't look good for MiningCorp. No matter what happened, we'd come out looking bad. I smiled tightly and nodded. "Loud and clear, D.K. Loud and clear."

Outside the ship Cranmer had done exactly as I had asked. The solid sphere was cut in half, and the crew was hollowing out the hemisphere using the FEL's depth-limiter. Using the interferometer, I confirmed that the sections were accurately carved to within a few micrometers. The magnetometer showed a variance in density along the sides, as expected, but nothing indicated that the material strength significantly deviated across the hemispheres.

I relaxed for the first time in what seemed months. My biggest worry had been that the asteroid would have vacuum pockets, or at least enough difference in material strength that the sphere wouldn't hold up against the air pressure once we dropped it into the atmosphere.

I gave the go-ahead for the gang to start fusing the sides together. Alignment was still critical, but the orientation sounder would sing out if the hemispheres weren't properly aligned.

During the relative calm, I started thinking about that crazy conversation I'd had inside the ship. Why would D.K. remain so emotionless when the State Department was dictating what MiningCorp should do?

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Anyone who had ever known D.K. would know that he doesn't put up with crap like that. In fact, it was his abhorrence of government rules that drove him to land the asteroid in the Saharan Hegemony in the first place. It just didn't make sense. If there was one thing that D.K. didn't put up with it was allowing government bean-counters to tell him how to run his company.

Julie Lattenbach, the company general counsel, was just as much an anomaly. Except for that one outburst, she wasn't exactly jumping up and defending the company's right to compete in a free enterprise. In fact, for a lawyer, she seemed to be awfully quiet.

It got me to thinking—which was bad, because I should have been paying more attention to what was going on outside of the ship. The gang had started welding the hemispheres together—each one, a kilometer in radius, dwarfed the tiny spacesuits that floated near its surface. The sphere started taking shape.

That brought me back to thinking about D.K. What exactly did he expect me to do? All this just because the Saharan Hegemony wanted to increase their royalties. I knew they'd capitulate if we floated the sphere over their capital—but what else was in it for MiningCorp? Would we be guaranteed that the next time we wanted to land an asteroid the Hegemony would grant us the right to do it? I know if I were them, I'd wonder what MiningCorp would hold them hostage for next.

It just didn't make sense: D.K.'s acquiescence to State, the government using us to threaten the Saharan Hegemony, MiningCorp's general counsel rolling over and playing dead . . . there had to be a message in there for me. It couldn't be anything else. D.K. trusted my judgment enough that he was willing to let me go alone on this, work autonomously.

I did it before, shutting down the Helium-3 project on the Moon—I'd do it again. But what did D.K. have in mind?

Normally, I'd just call him up on the company-private line—but I knew that Felton was monitoring our frequencies and he had the ability to break our code. So whatever it was that D.K. wanted, it was up to me to put the pieces together and come up with a solution. If it wasn't for all the crazy government rules that dominated our way of life, things would be so much easier. And it wasn't like anyone argued with the *intent* of the laws—we need to keep the environment safe, clean. But the way to do it isn't to paralyze the nation! It would have been the simplest thing just to float the rock down to White Sands, or even Nevada. Easier for MiningCorp, easier for the nation, and now even easier for the Saharan Hegemony.

If only our laws weren't so damned intertwined, tied up in self-serving interests; if only things were simpler. Things had been going downhill for years, and it seemed there were only two paths for the nation to follow: we'd either suffocate in the growing heap of conflicting laws, or we'd start over—wipe the slate clean and start

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from scratch. But the only way that would ever happen would be if a miracle occurred.

I studied the gang as they scurried over the sphere. . . .

And then it hit me—the answer, I thought, to what D.K. had been thinking all along.

Things couldn't get any worse. And if I were right, then maybe I'd been working with that miracle all along.

I bumped my chin mike, suddenly anxious to get back with the gang. "Cranmer—turn the gang over to Andrews and meet me by the ship. We have to reprogram the descent trajectory."

We didn't risk using nuclear reactor technology for the retrorockets. It wasn't that it wouldn't have worked, or even that it wasn't safe—rather the public's perception of having both a megaton of rock *and* a nuclear reactor float down on them at the same time was sure to cause riots. The LOX and liquid hydrogen rockets provided about half the specific impulse of the nukes anyway, so as long as the chemical retroengines worked I really didn't care.

A day later, after the fuel had arrived, the rockets worked like a charm. "First Time, Every Time," was stenciled on the titanium metal matrix making up the expander nozzles, and the quote proved to be accurate. But even with a few million pounds of thrust working against the sphere's inertia, it took a while to slow the evacuated vessel to where it started dropping into a lower orbit. I had the ship stay in orbit to monitor the descent.

Cranmer's computer simulations tracked the decaying orbit in real-time, keeping me updated on the position of the sphere. I keyed the link into MiningCorp's ground-based sensors and pasted their images onto my screen.

Cranmer insisted that the structure would keep below a standard deviation of max stress, even with the safety margins. But Cranmer's impeccable background notwithstanding—a Ph.D. from MIT in material science—I still insisted on following a shallow reentry, even if it meant skipping across the atmosphere a few times. After all, it was the first time we had floated anything this big, and I wanted to be sure we had all our ducks in line. And now, with the rock on its way, there was nothing anyone could do.

Orbiting Spaceguard sensors turned their eyes from scanning the heavens for near-Earth asteroids to looking down on the sphere. I had both Earth-based and space-based views up on the screen now. In the pilot compartment Ling Matsibiza found a commercial news broadcast that showed highlights of the public reaction. MiningCorp's PR people must have done a super job preparing the public for the drop, because aside from scattered "chicken little" reports, most of the press seemed to be taking everything in stride.

One newscaster showed a computer generated analysis of the flight plan—of how the rock would drop and start floating over the Atlantic, then be "pushed" by thrusters at a

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thousand feet above the ocean to Saharan Hegemony airspace. Everything looked as if it were going according to plan, and the newscasters reported millions of people waiting outside, watching the southern skies, looking for the giant behemoth to streak a hundred miles over their heads as it dipped lower into the atmosphere.

As the rock passed south of Hawaii, the newscaster warned of the upcoming burn. They predicted quite a sight: the thrusters firing over southern California, slowing the rock just enough so that by the time it reached the Atlantic, it would be floating over the ocean.

Cranmer's voice came over the link, breaking the cool sense of professionalism that had permeated the otherwise faultless descent. He was up front with Ling Matsibiza in the pilot compartment. "Uh, Stu—you still sure you want to do this?"

I briefly flashed back to my conversation with D.K. "You got it." I left the link open, "hot-mike," so I wouldn't have to keep clicking the intercom.

It took a moment for Cranmer's voice to come back. "OK, then. We're now reprogrammed to commence the final retroburn in seven seconds."

The computer generated trajectory started blinking on the screen, then the graphic of the rock was enveloped in a red ball at the same instant that the visual sensors showed the thrusters kicking in. The rock was a thousand miles from the California coast.

"We've got a burn!" Cranmer sounded uncharacteristically excited.

The news networks went crazy, yammering about the rock's thrusters firing too early and missing the projected trajectory by a thousand miles. "It should be over California before firing!" they screamed.

Data from laser altimeters melded with the visual sensors to give a 3-D panoramic view of the rock. It didn't even spin as it fell, dropping lower and lower—and weirdly enough, falling *slower* as it entered deeper into the atmosphere.

"Sensors reading ten to the minus eight average vacuum still holding up. It's working!"

Of course it's working, I thought. Otherwise the asteroid would be falling like a . . . well, a rock.

Langmuir probes embedded in the asteroid indicated a plasma forming at the leading edge as the sphere heated up; the overall temperatures didn't look too bad during the aerobraking phase. Gas spewed off the surface, causing the sphere to wobble. It looked like a giant black orb as it sank slower and slower.

It passed over the Appalachian Mountains when it stopped descending, a half-mile above ground level. It kept drifting to the east.

Cranmer's voice came over the intercom. "We've still got positive control, Stu. Do you want to take over?"

"Don't fix what's not broke," I said. "Are you sure it's holding up?"

"The sensors aren't recording any catastrophic stress, and there's still no discernible leakage. Vacuum's holding up as well."

"What about the thrusters?" I squinted at the readouts, trying to as-

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similate all the diagnostics.

"We show enough fuel left for plenty of maneuvering. You want to start breaching vacuum to bring this baby down?"

I had a vision of the two kilometer expanse of rock descending on the Virginia countryside. I didn't like the possibility that some cows might be crushed, not to mention any people. "No, we've go to ride this out. Keep it moving east."

"Roger that!" The excitement in Cranmer's voice was evident.

The screen blinked as D.K. came up over the video, overriding the newscasters and views of the rock. I heard shouting in the background, off-camera. D.K. tried to keep a straight face. "Stu, no need to tell you the government is kind of excited about what's happening. What went wrong?"

"Ah, thrusters kicked in a little early, D.K.—"

"Early!" Felton's angry red face came up next to D.K.'s. He waved his hand violently to someone next to him, then turned to face the camera. "Just what in the living hell is going on? Do you know that your asteroid is on a direct course to the nation's capital?"

I shrugged. *Oh well*, I thought. It's time to go all the way on this. Even if I back down now, they'll never let me go free; I might as well lay it out on the table. I drew in a deep breath.

"Mr. Felton, in one hour this rock will be floating directly over the U.S. Capitol building. We'll only be able to hold it in place for a short time—even if we don't breach the vacuum, diffusion losses will eventually cause the rock to start dropping. The way I figure it, you've got less than two days to do something about this country's problems."

"What?!"

"Well, not you directly—but Congress, the executive branch, and I guess the judicial branch had better hurry and clear up this regulatory constipation that's strangling our nation. In two days, if the problem isn't fixed, that rock is going to crush Washington DC. There's too much at stake for you to be arguing about this. The only way that rock is going to move is if your country gets its butt in gear and starts getting serious about being competitive again."

"*My* country?! It's your country too, Mendez, and you will be prosecuted to the full extent of the law—"

"MiningCorp employees are *personae non grata* in your country, Mr. Felton—check the legislation. It's part of the crap that's been tying America up for years: passing conflicting laws, ignoring responsibility for those statutes, playing pork-barrel politics. . . . The list goes on. But that's besides the point." I pressed an icon on the screen, and a detailed list of 738 laws—every one of them senseless, every one nearly overturned in Congress but tabled because of pork-politics—were faxed to D.K.'s office. "You now have less than forty-eight hours to repeal the legislation on the list I've just sent you and revamp the country."

Felton turned red. "The military will blow that thing out of the sky—"

"And risk killing even more peo-

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ple? I don't think so. Besides, the military can't do *anything* without an act of Congress nowadays, remember?"

"Then we'll take control of your retroengines!"

"How, by contracting it out? It will take a year just to announce the competition! You're wasting time, Felton—you've got forty-eight hours to get through that list."

Felton looked as if he were going to pop. I had to strain to hear his next comment. "And if we don't?"

I smiled. He *did* understand. "That megaton of rock tells its own story, Mr. Felton. With the asteroid over the Capitol, there won't be anything left of downtown Washington when it drops. However, I'll guarantee that no one will get killed if you start evacuating the city now—just to be safe. Forty-eight hours ought to be more than enough time to evacuate everybody out of the district."

Felton narrowed his eyes. His voice was so tight I could hardly hear him speak. "I thought you said you'd move the asteroid if Congress changed the laws."

"Oh, I did. But even with a million metric tons of rock dropping onto their lap, do you *really* think that will give them enough incentive to turn this country around?"

DATELINE—FOR IMMEDIATE RELEASE

The United States has announced that MiningCorp—the nation's first Federally Funded Commercial Technology Institute—is preparing to bring its second sphere of asteroid material down from orbit. After initially hovering over the nation's Capitol for less than two days, the first sphere was lowered onto the city, "ground zero" at the Capitol building. Remains from that sphere still envelop most of downtown D.C. (see sidebar on "Zero Crime Rate in Nation's Capital For Second Straight Month!"); and although outside sources indicate a three year supply of minerals can still be mined from the existing extraterrestrial rock, the United States insists the new asteroid will be downed at the old Nevada Test Site to supply an additional lode of minerals for the western states.

FLASH—NEWSNET

In an unusual flurry of activity, sources at the new U.S. State Department building in Denver have leaked the information that Mr. Ronald Felton, newly appointed Special Assistant to the President, has been dispatched to an undisclosed foreign country with urgent orders to evacuate all American citizens. Despite pointed questioning, the State department has denied that this is linked to an earlier White House announcement of the imminent landing of a second sphere supposedly targeted for the old Nevada Test Site. They also claim the timing of Mr. Felton's trip is purely coincidental with this landing. ■

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W. R. Thompson

ON TOUR WITH GYEZ

"When in Rome" is not always easy. . . .

Illustration by Todd Cameron Hamilton

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Gyez's native guide is a morph. At least that's what the note from his agent says, although the guide—a woman named Cygne—smells, looks, and walks like any other young human. She wears a cloak, kya-style, but she has the erect human posture and her only visible hair lies in a fashionably thin brunette crest atop a shaved head. Gyez's literary agent, who is human, has neglected to define *morph* for his client, and Gyez is fed up with asking humans to explain everything. He decides to tough it out.

Cygne approaches Gyez, then bows and sniffs in the polite kya greeting. "Coming to Earth, I hope you had a good trip," she says in Wideplain.

"Yes, I did." Gyez feels surprised. She speaks the kya language with impeccable grammar and accent. Most humans seem to mumble it and to retain their native sentence structures, even though their educational method—a combination of hypnotism, mnemonic drugs, and computer feedback—is supposed to be flawless. He decides that humans have improved their linguistic techniques. Change, he has been repeatedly told, is the one constant of human life.

Change is also a constant of kya life. A decade ago Kya was an isolated planet, and Gyez was writing his first books about atom-breakers and rocket-people from beyond the ionosphere. Now Kya is one of a hundred known worlds, Gyez's books are being reprinted on Earth, and he has traveled between the stars on a promotional tour. The tour is vital to his career. There are many more science fiction fans on Earth than on Kya, and if he can tap into that market his future—and income—are assured.

Cygne begins to speak to him about his itinerary, but Gyez interrupts her. "I would like to talk English," he says. "For the needful practicing." He has learned English the hard way.

"Certainly," she says, and they go to pick up Gyez's luggage. Humans cluster around a chute, and Gyez cannot see anything beyond them; the crouching kya posture puts his eye level below their shoulders. He and Cygne press to the front of the crowd. One by one roboticized suitcases and trunks emerge from the chute and seek out their owners. Gyez's suitcases, however, fall from the opening and lie on the tiles in an uncouth heap. "I hope they aren't broken," Cygne says in concern.

"They're always like this," Gyez tells her. His ears twitch in bemusement. Humans have only used roboticized luggage for a few years, but already they have forgotten there was a time when the owner supplied the brains and motive force. Gyez walks forward and takes the cases by their handles.

Cygne leads him out of the terminal and onto a bustling sidewalk. Gyez's muzzle wrinkles as he samples the rich, alien aromas of New Jersey. Smells are important to the kya, whose nose is infinitely more sensitive than its human counterpart; the air feels solid with the odors of humans and unknown materials. Computer work stations are everywhere, compact units on pedestals which can receive data through a score of

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input devices. Cygne steps up to one at the curbside and lays a hand on its rounded top. "A cab will be here in a minute," she tells Gyez.

"Good," he says. Despite a wish to appear sophisticated his head turns and cranes as he stares at his surroundings: robots, children on repulsor skates, a column of men in green robes, half of whom are holographs. Kya is not as technologically advanced as Earth; on Kya the cities are small and open, aircraft fly *via* propellers, and radio is the latest word in communications. Earth was in a similar state a century ago, and what Gyez sees here is a glimpse of his potential future.

Gyez takes a notepad from his cloak and writes down the things which surprise him. He always does this when he finds some tidbit that he might use in a story. The sidewalk is concrete; he had expected a conveyer belt. Some vehicles float above the ground or rise straight into the air, but others run on balloon wheels; the ozone generated by their electric motors bites his nose. The computer station has been spray-painted with obscure images and words.

Gyez asks Cygne about the symbolism. She puts her hand on the terminal again and smiles. Gyez has seen enough of this human expression to see there is something odd in Cygne's smile, as though the Universe is a warmly amusing joke. "Urban angst," she explains.

"I don't know that word." Gyez is still developing his vocabulary.

"It's dissatisfaction with the anonymity of modern life," she says. "Graffiti tells the world that you were here. We've been writing on the walls ever since the Stone Age. Even cavemen felt unhappy sometimes."

A tubby yellow car glides to a stop at the curbside. The car has a computer brain, but a human sits behind the steering mechanism. Gyez wonders if this is an effort to flatter him by his publisher, whose hopes for his market-potential are almost as high as his own.

There is nothing flattering about the driver, whose face contorts when he sees Cygne. "Walk, morph," he growls. The vehicle pulls away from the curb with a jerk. Gyez exhales in disgust, symbolically clearing the man's stench from his nose.

"Our cabbies are *très* eloquent," Cygne says in amusement. "I'll hail another cab."

"I'd like to try a bus," Gyez says. He wants to see how they differ from the familiar kya vehicle.

Cygne touches the station again, then leads Gyez down the sidewalk. "We're in luck," she tells him. "The cross-town bus runs straight to your hotel. We'll get there in plenty of time for you to settle in. You have an interview with *The New Yorker* at five, then you're meeting the Fantasy Writers Association at six. They're having a three-day convention, but you'll only attend the opening session."

"I'm sorry I can't spend more time with them," Gyez says. "Writing in the same genre, I might pick up some new ideas and techniques. After all, you people have been writing speculative fiction longer than we have."

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"Maybe I can arrange something later," Cygne says. "But there's not much slack in your itinerary."

"Will I have some time to play tourist?" Gyez asks. "I'd like to take in the scents."

"I'm sure we can make a few hours here and there," Cygne says. "Is there any place special you want to visit?"

"The Natural History Museum and the UN, of course," he says. "And the Empire State Building."

"It isn't here any more," Cygne says. "It's on exhibit in the Smithsonian, in Washington. You'll be there next Wednesday."

The bus is waiting when they reach the corner, and beyond the use of plastic and the lack of wheels it is like a kya bus. Cygne takes a seat when they board, but the L-shaped seats are awkward for the kya anatomy. Gyez remains standing, although he grips a stanchion to brace himself against motion.

Gyez snorts in sudden amusement. In every story he has set aboard a rocketship, he has had characters grip stanchions to keep from being flung about by wild accelerations. He has crossed fifty-odd light-years of space, however, and this is the first stanchion he has seen anywhere. He wonders if the bus is as safe as a starship, but when it starts to move the acceleration is not noticeable.

"I'm curious," Cygne says. "Why do you want to see the Empire State Building?"

"It was in a movie I watched on the ship," Gyez says. "*King Kong*. Seeing it, I was delighted."

"I love the classics, too." The bus drives across a bridge into Manhattan. Cygne points out landmarks: Broadway, Times Square, the Pylon. As she points Gyez notes something on the palm of her hand. It looks like a stylized human eye: a black disc encased in two black arcs.

Cygne is unself-conscious when Gyez mentions this. "Computer interfaces." She holds out both hands for him to see. The eyes are a thin, glossy tattoo on her palms. "They're part of my neural implants. I can hook into any nexus, or link with another morph. The discs are modem links and the arcs are alignment sensors."

"Mark of the beast," a nearby passenger mutters. His neighbor gives him an annoyed look. Gyez makes an entry in his notepad, although he restrains his curiosity. It is clear that morphs are an emotional topic with humans, and he does not want to begin his tour with an unpleasant incident. Cygne seems unperturbed by what is clearly a display of bad manners.

The ride has its high points. Halfway down the bus, Gyez sees a man who is reading a paperback book. The title, in English, is *Roam to Infinity*. It is one of the two books which Gyez has had published on Earth, and like all writers he is delighted to see somebody read his work. Gyez would like to talk to the man, who is his first human fan, but the bus is crowded and he does not want to shoulder his way through the crush.

Two people sit behind the reader. They are a man and a woman, and they hold hands. Among kya, handholding and handshaking are gestures

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used only by lovers; the palm-to-palm touch used by these two humans is an odd style, however, and weirdly erotic. Love secrets of the aliens, Gyez thinks. Even if he cannot work this particular detail into a story, he can use it at parties on Kya.

The bus makes several stops before it deposits Gyez and Cygne at the hotel. In the lobby Cygne lays a hand on a computer station—no, Gyez corrects himself, a nexus—then takes some keys from a slot. "You're in room five-twelve," Cygne tells him.

The hotel room's window commands an impressive view of the city and its environs. Gyez cannot see things as clearly as he would like. Almost automatically he takes off his glasses and polishes the lenses on the thick fur of his forearm. The act does little to clean the lenses, but it is better than nothing.

Cygne, who has been inspecting the room for his comfort, watches in interest. "Those are eyeglasses, aren't they?" she asks. "Are their mechanisms out of adjustment?"

"No, the lenses are just dirty."

She touches the room's nexus, then nods. "May I see them?"

Not wishing to seem rude, Gyez hands them to her, although if she breaks them he will have a problem. Blurrily, he watches as she looks at them, and through them, and then taps the lenses against the room's window. "I guess your eyes are bad," she says. "You should visit a doctor."

"I don't think they can operate on kya," Gyez says. He knows something about the human medical technology; they use laser surgery to correct bad eyesight.

"I'll ask if one can." Cygne returns the glasses and puts her hand back on the nexus. While she stands there Gyez inspects the glasses. They have not been this clean since his optometrist made them. Several scratches in the glass have vanished, and when he puts them over his muzzle the image is clear. "Microbots?" he asks. Humans do marvelous things with virus-sized robots.

"Yes." Her voice sounds dreamy. Linking into the nexus must distract her. "Let some window-cleaners jump from the window. Shouldn't wear out for a few months."

Cygne releases the nexus and her voice clears. "There's an optometrist in Louisville who's studied kya medicine. I've scheduled an appointment with her after your talk to the Bluegrass Literary Union."

" 'Bluegrass'?" Gyez repeats. Here's something interesting. He takes out his notepad and pen. "I've never heard of blue grass on any world. Being blue, doesn't it use chlorophyll?"

Cygne's hand goes back to the nexus, briefly. "It's green and it uses chlorophyll. I can't find a good explanation for the 'blue' name."

Gyez would ask more, but there is a knock at the door. When the door opens Cygne goes to it and greets the visitor by touching her palms to his. The man's face and hands seem oddly shaped, but Gyez is unsure of what to make of this.

"This is Charles," Cygne tells Gyez as they break contact. "He's from *The New Yorker*. I'll be back in a half-

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hour." She leaves.

Gyez has been interviewed many times before, and even though this is his first encounter with a human reporter he finds little difference from his experiences with the kya press. Once Charles gets past questions about the trip and Gyez's impressions of Earth, he asks such stock questions as *Where do you get your ideas* and *Do you do anything special when you write?* Only one question is new: *What sort of word processor do you use?* The answer, which is that Gyez uses a typewriter because the kya have not yet invented the word processor, leaves the man floundering. "I keep forgetting things are different on Kya," he apologizes.

"Quite all right," Gyez says. "Coming to Earth, I plan to buy a word processor, if I can find one that uses Wideplain."

"Oh." Charles has taken a seat close to the nexus. He reaches out and seems to stroke its top. "IBM and Orbidyne both have one on the market. The Orbidyne model's keyboard is better suited to the kya hand," he adds.

That goes into Gyez's notepad. "Speaking of hands, I saw you greet Cygne," he says. "Do you know each other well?" Everything is potential raw material for his writing, including morph-to-morph relations.

He chuckles. "We just interfaced to update one another. Cygne told me that *Roam to Infinity* is part of a series. When will the next book come out?"

Gyez tells Charles about the *Roamer* series, but he is happier when the man asks about *Nightscent*, which is his other Earthside publication. The *Roamer* books are sheer space opera, filled with adventurous kya spacers, their loyal human sidekicks, not-overly-probable aliens and galactic derring-do. *Nightscent* is a thoughtful, fictional treatment of the effect that contact with humanity has had on the kya. It tells how contact with aliens has strengthened and enriched the kya spirit, and Gyez is proud of it.

Cygne returns at a quarter to six. She touches palms with Charles, who leaves. As their touch breaks Gyez sees, for a brief moment, a faint purple sheen on her palms, as though she has gathered up handfuls of light. "A good interview," Cygne says after the door closes. "He'll make more people curious to read your books."

"Good," Gyez says, but it's too much. "Did he tell you about the whole interview? Touching your hand for only a few seconds, he couldn't have had the time."

"We adjusted our time-rate. Speaking of time, we're due at the FWA soon."

They go downstairs and catch a cab. The local sun has set, but the only indication of night is overhead, where the sky is a hazy silver from urban lighting. Gyez looks up through the cab's bubbletop. Shapes flit overhead, black silhouettes against the sky glow, like a vast swarm of confused birds. Several zip quite close to the cab as it floats along.

Gyez saw nothing like this during the day. Cygne explains that the shapes are high-speed delivery robots. They are not allowed to operate

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during the day because the sight makes people nervous; what if there is a crash? Yet it is all right for them to fly by night. Out of sight, out of mind, Cygne says. Gyez reflects on the importance of sight to the weak-nosed humans.

As the taxi stops at an intersection Gyez watches a robot slip down from the night. It hovers over a curbside nexus and extends a cable. Gyez sees that the cable ends in an interface identical to the ones on Cygne's palms. The robot communes briefly with the nexus, then vanishes upward.

The Fantasy Writers Association meets in the reception room of one of New York's ubiquitous hotels. No one has told the writers about kya customs, and Gyez shakes so many hands that he feels like the guest of honor at an orgy. Of course the gesture is a simple greeting among humans, but he is glad that no one takes any pictures, which would prove embarrassing back home.

There is a buffet table, and someone has provided a tray of kya food. Gyez picks up a canape, then retreats from the table; many human foods, especially the cooked meats, stink intolerably. He bumps into a cluster of writers and introductions are made all around, although names are soon forgotten. As Gyez has hoped, the conversation concerns writing. None of these people have read his books, but they listen politely as he describes *Nightscent* and *Roam to Infinity*. Gyez thinks they are amused by stories about robots and rockets.

"Last month I published a novel about a modern family," a tall man tells Gyez, as though to assure him that contemporary topics are not taboo. "All my other books have been set way back in the twentieth century, but I couldn't resist the artistic challenge of writing a contemporary fantasy." The writer outlines the story, which concerns a man and a woman who live on a farm, grow corn, have a baby, and decide to do it all over again next year. End of story.

Gyez sniffs. "Hearing this, I missed the fantasy element," he says apologetically.

"It's the *way* they do everything that's fantastic," the tall man says. "No cybernetics, no gengineering, everything authentically twen-cen. PEN and La Société Critique Américaine have already nominated it for their fantasy awards," he adds with pride. Gyez sniffs in sudden comprehension; on Earth, what could could be more fantastic than a lack of change?

"Is that *The Farmers of the Dell?*" a woman asks. "Higgins told me that you wrote it with the new WordForm software."

"WordForm 12.0," he says with a nod. "It let me cybernate all the characters. The depth and realism amazed me."

" 'Cybernate'?" Gyez repeats. "I don't know that word." He is growing weary of that phrase.

"A computer simulation of a character," the tall man says. "It lets you interview your characters. Here, I'll show you—" He reaches into his vest pocket, then stops. "I left my word processor in my other coat. I'll be back." He leaves.

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One of the writers sees something and sniffs in disdain, one of the few gestures shared by Humans and kya. "I *wish* they wouldn't do that in public," she grumbles. "It's disgusting."

Gyez follows her gaze. He sees Cygne and a woman, facing one another with their palms touching. They smile lazily, and they circle one another as though performing some stately, arcane dance. It is nothing like the brief contacts she shared with Charles and the various nexi. "What *are* they doing?" Gyez asks.

"Linking," the woman says. "They say it's better than sex—you know how morphs are."

"No, I don't," Gyez tells her. "I'm not even sure what the word means." This is a considerable understatement, but he is reluctant to confess the full extent of his ignorance.

This surprises the woman. "It's short for *metamorphite*," she explains. "It's a cognate of a Greek word meaning *change*."

"Ah," Gyez says. He gets out his notepad and writes this down. "Having computer-stuff wired into their flesh, I suppose they *have* changed."

"Or decayed," she says. "The implants let them change their personalities and emotions. Since these are what make us human, you can't really say morphs are still human, can you?"

Gyez says nothing; the question is clearly rhetorical. Meanwhile a man approaches Cygne and her companion. He speaks sharp, harsh words to them. The two women laugh and leave the room. This makes Gyez uncomfortable. He likes Cygne; should he leave to register solidarity with a friend? On the other hand (he winces at the metaphor), perhaps this hand-touching is an unacceptable gesture in public.

If this was a story, Gyez would know how to resolve the conflict, but he cannot decide now. He has always dealt better with fictional people and situations than with their real counterparts. He must consider the harm that a walk-out could do to his tour. It would reflect badly on him and it might cut into his sales. Those are good reasons to keep quiet, but he remains troubled.

The tall man returns, ending Gyez's internal debate. He pulls a cloth from his pocket, and when he presses a thumb to its corner the fabric turns into a rigid square the size of a dinner plate. "Audio on," the man tells the computer. "Load WordForm. Audit Henry."

A man's face appears on the plate and speaks in a surly voice. "Whaddya want, butthead?"

"Tell us about yourself, Henry," the man says.

"What's to tell? I work with my hands. If it breaks, I can fix it."

"Who do you work for?" the man asks.

"A couple from Philly. They bought out the old McCready place, and the Heat told me to work for them or get morphed."

The tall man turns to Gyez. "I gave the computer Henry's general characteristics and life story—rude, greedy and lazy, a convicted burglar, but good with machinery—and it filled in the rest of his personality. Ask him something, but keep it simple."

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he cautions. "This machine isn't hyper."

"I see." Gyez sniffs appreciatively. He realizes that he has a chance to learn something without seeming too foolish. "Henry, what do you know about morphs?"

"Buncha jerks," the computer says. Several humans nod in agreement. "There oughtta be a law."

"What sort of law?" Gyez asks.

"Against them. Hey, who are you? You talk funny."

"I'm from Kya," Gyez says.

"Damn foreigners. There oughta be a law."

Despite himself Gyez gives the computer a rude snort. "He's not very friendly, is he?" he asks the tall man.

"That's the whole point," the man says. "The computer's reactions are realistic, so you can learn how a character might react to any event, or create a character that suits a plot, or even see how two characters will interact—that helps when you write the dialogue."

To Gyez, it seems too good to be true. His fur bristles in envy. "Being so complex, it must take a lot of work to set up a character," he says.

"Not at all. Here, try it yourself. Create a character," the man tells the computer, before he hands it to Gyez.

"Ready," the computer says in a brisk female voice. "Name of character."

"Er—Wu Mohammed," Gyez says, using names he heard on the starship. The computer asks him a string of questions about the character: sex, age, physical description, distinguishing characteristics. "He's a morph," Gyez says.

"Memory overflow," the computer says. "Program aborted."

"You can't run a morph as a character," the tall man says. His tone suggests Gyez is an idiot to have tried that. He takes the computer from Gyez, folds it up and tucks it into his pocket. "WordForm can only cybernate unchanging characters. Morphs change their personalities at the drop of a hat. How can you write about characters like *that?*"

"The same way you write about anything else," Gyez suggests. He is annoyed. He has written about so many outré characters—robots, mechikyas, cometeers, humans, blorches—that he cannot imagine a writer balking at such an elementary challenge. "It isn't the machine that does your writing, is it?"

A woman glowers at Gyez. "Are you saying we should write about *morphs?* I won't take that kind of talk from someone who writes *mainstream* fiction!" She stalks out of the room in a sulfur-smoldering rage, to borrow a phrase which Gyez has used in many of his stories.

The tall man is slow to anger, but mighty in his wrath. "I suppose that you *like* morphs?" he declaims.

"Bolt yourself down, Ira," another writer says in annoyance. "The wanker prolly doesn't know about morphs." He faces Gyez. "They're hoods, morons, devos, flatbrains —scum wired up at public expense. Our tax dollars at work."

"It's not all bad," a woman says venturously. "Computer implants have eliminated mental illness and re-

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cidivism."

"And now we've got something worse," yet another writer says. The humans in the reception room are slowly clustering around Gyez and the tall man, drawn by the sounds of controversy. "What happens when the government decides to force normal people to wire up?"

Gyez thinks that the woman looks irked. "It hasn't happened yet," she says adamantly.

"You think it's so good, *you* try it," someone says loudly. "Like those perverts who morph because they think it's an improvement—"

"—in some ways it is—"

"—the way crims get away with murder, like rewiring them is real punishment—"

"—not the end of the world—"

"—fixing up mental defectives so they can take jobs away from normal folks and pass on their genes—"

Other writers join the dispute, and the growing roar turns into a babble in Gyez's ears. He's not sure why everyone is shouting at one another, but it's obvious that events are now out of control. There is a *crack* as a fist impacts on a chin. Gyez hastens toward the door, where he makes an unobtrusive exit. Under normal circumstances it would be hard for a kya to be unobtrusive among humans, but he is aided by the growing brawl, and for once he decides against taking notes.

Gyez searches the corridor and hotel lobby. Cygne has vanished, which is no surprise; Gyez was scheduled to remain here for several more hours. Feeling as adventurous as any of his heroes, he exits the hotel and summons a cab. The robot driver is quite competent, and he has no trouble returning to his hotel.

Once he is back in his room he goes to the computer nexus. He has no idea of how to use it, however, as the controls are labeled only with obscure pictograms; it has something to do with a human custom which demands that complex machinery be designed for use by illiterates. After a frustrated moment Gyez grumbles something aromatic in Wideplain.

"Speaking so, is there a problem?" the nexus asks in the same language.

It can speak? "I'd like to read a book," Gyez says, swiftly recovering from his surprise. "*The Farmers of the Dell.* Is it available in Wideplain translation?"

"Yes," the nexus tells him. "Being on-line, would you like to read it now?"

Gyez would. He is a fast reader, and the book which appears on the viewer is neither long nor complex. Indeed, the chapter titles aptly sum up the action: The Farm Is Bought. Henry Is Hired. Corn Is Planted. There is Rain. The Baby Is Born. The Baby Is Changed.

This last title is especially disappointing, because nothing changes except a garment, and the change is not for the better. Nevertheless Gyez perseveres, because the descriptions of the characters are at once brief and illuminating. A robot arrives with his dinner while he is halfway through the book, and he eats as he finishes the novel. The corn is harvested and stored for the winter, and the baby is

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given a name. Henry decides that he prefers life on the farm, amid the mud and manure, to becoming a morph. The farming couple decides that next year will be exactly like last year. This thought pleases them.

It all puzzles Gyez. The book is written as though change is a bad thing, and that's an attitude he can't understand. All of the changes he's seen in his life have been for the better; there are still problems on Kya, but as he likes to say, they're a better class of problem these days.

Cygne returns shortly after Gyez finishes the book. "I'm sorry I didn't stay around," she says. "I didn't expect you would have trouble."

"Quite all right," Gyez says. "It was an unusual experience, although I thought about leaving earlier."

"Why?" she asks, puzzled. "They're interesting people."

"Er, yes, but I thought I should give them a whiff of my displeasure with their rudeness. Throwing you out, they *were* rude, weren't they?" He is suddenly uncertain. With humans, who can say?

Cygne nods. "They were rude, but I can't blame them."

"Why not?" Gyez asks. "They're responsible for their behavior."

"Well, it's hard for normal people to change their feelings. A lot of us morphs started as criminals, or had mental problems. They remember what we used to be."

"Ah," Gyez says, recalling what he heard before the fight began. He gets out his notepad, sensing a story here. "So there's a stigma attached to being a morph? It seems unfair."

"It is if you were born with Down's Syndrome, like Charles, or if a stroke wiped out part of your brain," Cygne says. "But take me. A hundred years ago I would have been executed after I murdered a—"

Gyez lets out a shocked *gronk*. "You're a killer?"

She nods. "I polyphased a man. At one time I would have been executed or locked up for life. That prevents recidivism, you see? But it's inefficient. A criminal can't repay her debt to society if she's dead or in jail."

"So how does being morphed let you repay?" Gyez is suddenly delicate. He does not want to annoy an admitted killer.

Cygne smiles at his disquiet. "Don't worry. The judge ordered my personality restructured so I can't become violent. My victim's family gets half of my earnings, and I make a lot more this way than I could in prison. Plus, society doesn't have to pay to keep me in jail for the rest of my life."

Curiosity overcomes Gyez's apprehension. "Don't you resent this restructuredizing?"

"Restructuring," Cygne says, and smiles again. "I was restructured so I wouldn't resent it. Besides, I've done a lot of restructuring on my own. I didn't like who I used to be even before I morphed."

Gyez feels his muzzle twitch nervously. "I don't mean to be rude, but what's to keep you from restructuring yourself to become violent again?"

"The anti-violence compulsion is hardwired into me," she says. "Plus, every time I link into the net a moni-

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tor program makes sure I haven't found a way to restructure myself into a criminal. There are other safeguards, but it's late and you should go to sleep now. You have to get up early tomorrow."

Cygne leaves the room. Gyez, who is not tired, asks the computer for data about metamorphites. He is inundated with statistics. The metamorphic "operation" consists of injections of microbots and a carbon-silicon compound; the microbots turn the compound into nanochips and thready neural links which infiltrate the central nervous system and form a parallel structure with it. Interfaces transfer data through ultraviolet light. Morphs can expand their own memories and mental abilities through the worldwide computer network. Morphs usually work as cyberneticians, encyclopedists, researchers, and data collators, but they like to dabble in fields which require human contact.

Gyez quits the computer. The facts tell him nothing. He wants to know why humans resent morphs, how morphs fit into society, what it is like to be a morph. How much of a morph's personality resides in the electronic structure, and why does it make the soul so plastic? The computer may hold the answers, but if so they are as obscure as the illiterate symbols on the nexus.

The room contains a bulky, padded box called a bed. Humans sleep on it, stretched flat on their backs, a position impossible for kya. Happily, the carpet is thick and sensual under his bare feet. When he is rich, Gyez tells himself, he will own a house with carpet like this; this is an easier thought to maintain than reflections on morphs. He crouches on the carpet, rests his hands and chin on his knees, and goes to sleep.

Gyez awakes in the morning, brushes his fur and puts on a fresh cloak. Cygne arrives while he has breakfast, and she reviews the day's schedule. He will sign autographs at a midtown bookstore this morning; he has a dinner interview with a prestigious literary critic, followed by a second signing at a downtown bookstore in the evening; he will guest on a talk show at night. "Your afternoon is free," Cygne says.

Gyez swallows the last bite of his stripleaf sandwich. "Wasn't I supposed to speak with a college group?"

"They canceled out," she says.

"Why?" he asks, alarmed. He feels certain this is a repercussion from last night's ruckus. Bad news travels translight, as humans say.

"They wouldn't tell me," Cygne says. "But college groups can be volatile about their interests, so don't let it upset you. There's a reporter who wants to see you. I can schedule him in."

Gyez agrees to this. Cygne puts her hand on the nexus and makes arrangements. "What's using a nexus like?" Gyez asks her.

"Mmm . . ." She removes her hand from the nexus. "It's like waking from a dream—do kya dream?"

"Yes. Our brains are a lot like yours." He sniffs thoughtfully. "People being different, dreams aren't always alike. So how would you say us-

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ing a nexus is like a dream?"

"Oh!" Cygne puts her hands over her mouth and giggles. "Being *off* the net is like dreaming. Everything is vague and I feel only half-awake. Conversations are hard. Have you ever had a dream where people talk nonsense, and you can't make yourself understood, and you don't feel smart enough to understand what's going on? That's what this is like."

Gyez's muzzle twitches in perplexity. "Our conversations all make sense."

"You only think they do," she says. "Words have such a limited bandwidth that you can't understand how much we miss. I can't even explain it like this."

Gyez exhales in annoyance. He has used such lines in several of his stories, when he has found that the ideas he wishes to express are too subtle for his prose style. Serves me right, he thinks, but he's determined to get *something* concrete out of Cygne. "What about linking with another morph?"

"It's very nice," she says. "You stretch your time-sense and trade everything, until you both know all about one another."

"Instant friendship," he suggests.

She nods vigorously, pleased that she has taught him something. "Of course it only seems instant to someone who's watching," she says. "But when you've got a new friend, who cares about time?"

He doesn't know how to answer that question. "Suppose you don't like the person you're linked with," he says. "What happens then?"

"We restructure one another so we can become friends," she says. "I've picked up some very nice changes that way. Now we really have to go."

They leave the hotel, and Cygne summons a cab which takes them to the bookstore where Gyez will sign autographs. Although the store specializes in electronic books, there is enough paper and ink here to give the shop the solid, familiar scent of a bookstore. The shopkeeper is an aging woman with dark skin. Her eyes narrow to slits when she sees Cygne, and Gyez reads this as a sign of hostility. So, it would seem, does Cygne, who gives the woman a casual nod and speaks to Gyez. "I'll come back at noon," she says. She leaves.

The shop is busy, and Gyez spends the next three hours signing his autograph. He keeps a pen in his right hand, which lets him avoid the embarrassment of shaking hands. Noon arrives, ending the session, and the shopkeeper takes Gyez into her office. "I think that's the most customers we've ever had for a signing," she says as she pours herself a cup of coffee. She sits down and eyes him over the cup. "After last night I was afraid people would stay away."

"Why?" Gyez asks.

"You know, the mess at that writers' thing," the woman says. "People were saying you like morphs. I hear NYU ex'ed you out over this. But you're nominal."

"Hearing that, I'm glad you think so." Gyez sniffs thoughtfully. The woman seems expansive, no doubt because he brought a lot of business into her store. He is not above ex-

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ploiting this; when it comes to satisfying his curiosity Gyez is quite normal. "I still don't understand what's wrong with morphs," he says.

"Plenty," the shopkeeper says, and sips her coffee. "Nobody really understands them. They're unpredictable. Nine-tenths of their 'personalities' are really computer software and they're always redoing their programs, changing themselves and what they feel."

"Isn't that their business?" Gyez asks.

The woman shakes her head. "Nobody would mind if they didn't have so much power. Suppose one of them decides it would be fun to hate everyone, and it crashes the computer nets to spite us, or—or anything? It could happen, and none of us would know about it until it's too late." She stares into her coffee cup as though searching it for words. "When you change everything, even what you feel, it's like being lost at sea without a compass or landmarks. Take away everything that's familiar and you may as well be dead."

Gyez sniffs thoughtfully, then adds a nod for her benefit. He sees that she is not afraid of anything specific. It is the unknowns created by change which frighten her, and he realizes that change is not so wonderful as he had thought. Change everything, and you lose everything. "Hearing all this, I wonder why you people even have morphs," he says at last.

"Some jobs are too complex for real people," she says, and drinks her coffee. "And life gets more complicated all the time. You kya are lucky, you don't need morphs—yet."

"Maybe we never will." Gyez decides that he will call his agent and ask for a new guide. Cygne could harm his career and he doesn't need that. This won't be the first time he has walked away from someone who is no longer useful to him, but he tells himself this won't hurt her feelings. She will simply restructure herself one more time, and all will be forgotten.

Cygne returns then, walking through the office door. The shopkeeper snaps angrily at Cygne. "Did I say you could come in here?" she demands.

Cygne smiles. "My apologies."

"You think this is funny?" the woman shouts. She throws her coffee cup at Cygne and lunges at her. Cygne dodges the cup, but the woman's impact hurls her against the wall.

Cygne seems uninjuried; deftly, she grabs the woman by the wrists. "You really shouldn't do this," Cygne says.

Although Gyez has the kya aversion to touching strangers, he pulls the woman away from Cygne. The shopkeeper shakes free of him and backs off. "Get *out*," she snarls.

Gyez and Cygne hasten out of the store. The sidewalk is neither crowded nor empty. "Are you all right?" he asks as they reach the curb. His hands retain the scent of the shopkeeper, and he rubs them together in a half-conscious effort to remove the odor.

Cygne nods. "I'm fine, thank you." Her hand strokes a curbside nexus, summoning a cab.

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"Acting as you did, I don't think—" Gyez stops. "Doesn't the restructuring let you defend yourself?"

"I *did* defend—oh, you mean fighting. No. I'm not allowed to do anything that might hurt other people."

"You could be hurt," Gyez says.

"Justice," Cygne says. "The judge told me that was the chance I take."

Her casual tone is wildly inappropriate for the remark. "Doesn't your life mean anything to you?" he asks.

Cygne smiles and nods. "More than it ever did."

So amused! Gyez begins to understand why Cygne enraged the shopkeeper. Does she smile because she thinks Gyez and all the others are dream-creatures, less real than herself? "This life may smell like a dream to you," he says, "but if it ends, so does your morph-world."

"This life isn't a dream," Cygne says in gentle frustration. "I'm bad with analogies. Let's see. I never had friends before, and I was always lonely. I ruined my life because I was greedy and selfish, that's why I killed a man. Now I have friends, I know *how* to have friends, and even if it ends tonight because I'm not allowed to hurt anyone, it's worth the price."

She stops, and at first Gyez thinks she is waiting for his response. Then he notices a dim violet glow which seems to come from everywhere. Two humans approach Cygne; they grab her cloak, and as the clasp pops open at her throat they turn it inside out and rifle its pockets. Cygne merely stands still, a smile frozen on her lips.

Gyez grabs one of the humans and pulls him away from Cygne. The human swings a fist at Gyez, who returns the gesture; the blows land, but as neither knows much about the other's anatomy no damage is done. Nevertheless Gyez perseveres, and for a moment he gives better than he gets, but then the second human comes to the aid of the first. Kya have a poor sense of balance, and when a foot catches Gyez by the ankle he goes tumbling. He has a glimpse of the street—Cygne oblivious to reality, traffic, a man down the sidewalk who stands with one hand on a nexus—and then his back slams into the concrete.

Gyez loses his breath and his glasses as he strikes the ground, and a harsh crackling tells him his glasses are broken. The world is reduced to a blur, but he can still smell his opponents, and that's enough for him. He gets up and goes after the one who smells of wool and leather. The he feels something hard and red-hot in his side, and his knees buckle; he feels very short of breath as he falls to the pavement. He smells blood. It is kya blood, and a corner of his mind tells him that it must be his own. He knows he is dying.

Now a third human joins the fight. This one is blurred as much by speed as by myopia, and within seconds he puts the two attackers on the ground. Gyez's rescuer pauses, then goes to Cygne. He raises one of her hands, and despite the blurriness Gyez sees him press his palm to hers. Then he returns to Gyez and presses a hand to his chest.

Cygne shakes out of her reverie.

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"Oh!" she says. "I'll call an ambulance." She steps over to the nearest nexus. Gyez can no longer see her because his vision fades out. Sounds and smells vanish. The agony in his chest ends.

The ambulance arrives and Gyez is lifted into the emergency van. Its air is thick with astringent scents and human odors, and he is dimly aware that an air tube is slid down his throat. He can see and hear well enough now. Gyez lies on his side atop a stretcher, and Cygne rides next to him. "Gyez, you shouldn't have taken the chance," she says. "Now you're hurt and this is going to inconvenience you."

That is true, he thinks. It is very hard to get blood out of matted fur, especially when the fur is as thick as his. And the scar will leave an unaesthetic bald spot. Other than that he does not feel concerned. This is *Earth,* where everything that happens next is just another miracle. "You weren't hurt, were you?" he asks Cygne. Despite the tube and his shortness of breath his voice is firm. He is more surprised by his question, which he realizes is not typical of himself. He knows he is self-centered.

"The uvvers didn't hurt me," Cygne assures him. When Gyez asks about the word—his curiosity is unharmed—Cygne explains what happened to her, as simply as a child stacking blocks. Uvvers use an ultraviolet hologram to inject coded pulses into a morph's interface; the name comes from UV, the acronym for ultraviolet. The pulses obliterate the morph's time-sense. The uvvers loot the paralyzed victim and move on. Morphs restructure themselves so they don't mind, and few normal humans care. It keeps the uvvers from committing violent crimes, which pleases everyone.

Gyez wants to write all this in his notepad. He is intrigued by her attitude toward theft; she seems to regard the uvvers as she would naughty children, and she thinks his attack was an overreaction. He realizes this is because she has restructured her personality; her self-sacrificing attitude is at once artificial and sincere. Just the same he is glad he fought; they might have harmed her—how could he have known otherwise?—and although he had thought about firing her, coming to a friend's defense was the sort of thing any decent kya would do. When he was a child he had a big book which told about heroes who looked after their friends, and he remembers its stories about Trid and Ryov and Ksyu just as clearly as he recalls the intoxicating scent of fresh ink on crisp new paper. He also remembers how the stories filled him with admiration, and his half-formed wish to learn how to make words do that for other people.

Cygne tires of his rambling. "You should sleep now," she says. "You'll be all right when you wake up, and we can talk more then." That sounds like a good idea, and Gyez goes to sleep.

He wakes up in a room in a human hospital. He is crouched on the floor, and aside from his hunger he feels quite well. His vision is sharp and clear, although he wears no glasses;

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he decides that he was given eye surgery while unconscious. Oddly, his fur is clean and well-brushed. There is no matting, so perhaps he did not bleed as much as he recalls. The spot where he was stabbed is still tender, however. He fingers it and feels the solid beat of his heart. He is so stunned to realize that he was stabbed in the heart that he almost overlooks the interfaces on his mottled tan palms.

Gyez is still staring at them when Cygne enters the room. "We thought you would sleep much longer," she says. "You must be hungry."

"I'm a lot more than that," he said. Gyez decides he would feel upset if he wasn't so bewildered. This is like being a test subject at a practical-joke institute. He holds up his hands, palms out. "Doing this, I *hope* you had a good reason?"

"You were very badly injured," Cygne tells him. "Let me show you how to order breakfast, and then I'll fill you in."

She leads Gyez to the room's nexus. She pushes her palm against one of his. As if following an old habit he places his free hand on the nexus and—

—alignment—give ID—

Gyez sniffs at the thought-voice in his head, and Cygne walks him through his first fumbling steps. He identifies himself, follows something called a directory path and accesses several menus. One such menu is quite literally that, and he picks a meal from it. Then Cygne logs him off, and the nexus' thought-voice notes that he has been on-line for six-point-eight seconds.

The contact breaks and he does not wish to resume it. Her presence in his mind felt intrusive, and Cygne does not press the point. "The doctors said I shouldn't explain anything until after you eat," she tells Gyez as she gives him a cleansing cloth to wipe the scents from his hands. "You've been here for almost a week, and you haven't had any solid food."

"A knife in the heart being serious, I'm not surprised I was out for a week," he says. He paces the room's floor, working the aches out of his joints. Back on Kya such an injury would have meant months in a hospital, assuming he had survived. But here? "Or should I be surprised that it took a whole week to heal me?"

"We had to do a lot of work," Cygne admits. "And a lot of research. Humans have never done major surgery on kya before."

He nods. "You fixed my eyesight."

"The implants correct the distortion," she says. "We've been computer-enhancing images for, um, a long time. You still should have eye surgery."

Gyez is curious about the details, but a cart floats in with his meal and Cygne refuses to talk about anything besides his tour. The schedule has been disrupted but people still want to meet him. The publicity over the attack has added to public interest. It might be worthwhile to extend his tour.

The talk is reassuring in its normality, but Gyez feels a growing unease as he finishes his meal. He becomes aware of discrepancies in what he re-

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members. He recalls a long conversation with Cygne in the ambulance, even though he had a hole in his heart and an air tube in his throat. They discussed his childhood, his education and his writing during the brief ride to the hospital. "How badly was I hurt?" he asks. "I remember . . . we talked so *much*. . . ."

"We had to play games with your memory," she says, seeing his confusion. She holds out a hand, palm out. Violet light plays across the interface. "Let me show you what happened. It's a memory from the man who helped us."

Gyez hesitates, but he wants to know. His hand does not match Cygne's long, narrow human hand, but he makes contact and feels—

alignment

—and he remembers standing on the street near the book store, tall and comfortable in a furless human body. His (the body, the mind are assertively male, and named Lyndon) sense of smell is feeble, as though he breathes through a thick cotton cloth, but his eyesight is quite sharp. There is a purple flicker which Lyndon knows is an uvver's mindjacking pulse, attenuated by distance, and he looks around to see if a morph is going to need help.

Lyndon sees an alien fighting a couple of men. That's not good; uvvers can turn dangerous and the poor guy doesn't know the situation. He reaches out and puts his hand on a nexus. He summons the police, but even before they can respond he reasons that the alien needs help now. He follows a directory path and downloads judo reflexes into his system. For the first time in his life he fears the possibility of death, and he restructures himself to overcome that fear.

Charging into the fight seems to take forever, and not merely because he has stretched his time sense. The alien has been stabbed in the chest and red-brown blood soaks his fur even as he falls. One of the uvvers is kneeling to stab the alien again, but the man drops the knife when Lyndon delivers a stunning pair of blows. Lyndon flips around and in seconds the other uvver, who is raising a holoprojector to jam his interface, is rendered harmless.

Lyndon looks down at the alien, whose eyes are wide with terror. He recognizes the furry being as Gyez, the writer he downloaded from the net last night. He goes to the woman who stands near him, takes her hand and interfaces with her. He runs several unlocking codes before he finds the correct spellbreaker. It will take her a moment to return to reality, so he leaves a message in her input buffer and joins Gyez.

The alien lies in a spreading pool of blood. Lyndon places a hand over the knife hole and tries to staunch the flow, but it is futile. While Cygne speaks of calling an ambulance, he feels Gyez's damaged heart flutter to a stop.

—end download—

Gyez shakes his head vigorously and pulls his hand away from Cygne's palm. He is rattled by the sight of his death, by the touch of his heart's final beats. "But I remember—" he begins.

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"Give yourself a moment," Cygne advises him.

Gyez is too rattled to argue. The room has a window and he stands at it for a moment. He sees part of a large green statue, which tells him he is still in New York. At least he was not moved around while he was unconscious, which seems comforting. And he did not stay dead. Humans have been reviving one another for decades. It is one of the numerous miracles they take for granted.

Gyez rejoins Cygne. "So, I died," he says, regaining some of his composure. "I suppose I'll never live it down. But why did you morph me?"

"We had some trouble," she says, and holds up her hand. Gyez tries to appear nonchalant as he touches his palm to hers again, but his hand trembles with his reluctance.

The process is easier this time, less disorienting. He remembers who he is even as he relives his death through Cygne's eyes, and he remains vaguely conscious of his presence with Cygne in the hospital room. In this vivid memory Cygne links with Lyndon, but neither of them can think of a way to aid Gyez. His eyes are fixed and glassy when the ambulance finally arrives, and his heart has been still for at least five minutes. Cygne climbs into the ambulance with the emergency medical team, who pump an oxygenated fluorocarbon fluid into his empty circulatory system. His body is chilled to minimize tissue damage, but Gyez has been dead so long that brain damage may be inevitable.

Cygne spends a long night at a hospital. The kya legation sends a doctor who advises the human physicians on maintaining Gyez's body during the repairs. He is revived early the next morning, but tests soon reveal he has suffered brain damage. He has no control over his body; his memories appear to be intact, but he cannot access them; he shows degraded responses on several psychological functions.

The doctors refuse to admit defeat merely because Gyez's mind lies in ruins. He is given injections of carbon-silicon compounds and microbots. His health is carefully monitored for several days while the new circuits infiltrate his flesh. There is no trouble; the microbots are versatile enough to service a kya's body, and when they complete their work he is a morph.

Meanwhile Cygne undergoes some specific medical training. She links with a therapist who shows her how to reintegrate a fragmented mind and create new mental structures to replace the missing parts. It is somewhat like taking a book with missing pages and rewriting the lost material; the new material must be consistent with what is left of the old.

Over a period of several hours (objective time) she links with Gyez and puts him back together. What remains of Gyez responds to her; as the therapist had hoped, she is a familiar landmark on which he may reorient himself. The virtual reality of a conversation during an ambulance ride, with Gyez's time-sense rendered irrelevant, allows Cygne to check the restoration and cushion him against

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the shock of his own death. Several times he grows aware of what has happened to him, but Cygne blanks out the awareness along with his rising panic. It is as easy for her to adjust Gyez's emotions as it is for her to control her own feelings. When everything is done Gyez is allowed to sleep until he is ready to waken; Cygne brushes out his mussed fur, then rests herself.

This is too far beyond his experience. Gyez breaks the link and pulls away from her. Who is he and what is he? Is he Gyez, or a reconstruction which only remembers being Gyez? And Cygne knows every secret he has, as well as every flaw of greed and selfishness. He has never been this confused and afraid in his life.

"I can help you," Cygne says.

Gyez looks at her with eyes made clear by his implants. "It wasn't easy for me at first, either," she says. "You don't have to feel afraid if you don't want to." She holds out her hand, palm up, and violet light ripples expectantly across the interface. Her smile is gone, and Gyez knows enough about humans to realize that her expression is earnest.

Gyez sees that some things are only strengthened by change. There is love, and friendship, and compassion. His fear fades even before he touches her hand. ■

IN TIMES TO COME

Our November issue features two big stories and two short ones. The cover story is Tom Ligon's "The Gardener," which some of you may recognize as a sequel to 1986's "The Devil and the Deep Black Void." (But don't worry if you don't—the earlier story is *not* a prerequisite!) Is remaking a world to suit your own needs an act of creation, or destruction? And what if two groups are working on different parts of the same world, and what should be done?

The other novella, Daniel Hatch's "Senator Space Cadet," is (as the name suggests) something for the season, and for our own time. It offers not only some good ideas on how space advocates might utilize the political process, but also a considerably clearer vision than most politicians have of how that political process itself is likely to change in the quite near future.

The short pieces are by Jeffery D. Kooistra (whose "Love, Dad" you voted your favorite among last year's short stories) and Michael F. Flynn (who has been an *Analog* favorite for some years now). Dr. Gay E. Canough returns with the fact article, on "Working Up to Space Solar Power." Sometimes a desirable goal seems just too big and distant to attain—until you realize you can get there in small steps!

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THE TACHYON DRIVE: INFINITE EXHAUST VELOCITY AT ZERO ENERGY COST

We are told by the well-tested physics orthodoxy of special relativity that neither information nor material objects can travel faster than light speed, **c** = 3 × 10^8 meters per second. If an object with rest mass **M** had a velocity equal to **c**, its mass-energy would be infinite. Therefore, it would require all the energy in the Universe and more to accelerate the object to a velocity of **c**. If the massive object could somehow be drop-kicked *over* the light-speed barrier so that its velocity was greater than **c**, then its mass-energy **E** would become *imaginary* quantities (like $\sqrt{-1}$). This, says physics orthodoxy, is Nature's way of telling us that such quantities have nothing to do with our Universe, in which all measurable physical variables must have real (not imaginary) numbers as values.

"Not so!" said Gerald Feinberg, the eminent physicist and SF fan who died last year at the age of 59. In a 1967 paper, Feinberg postulated a type of hypothetical particles with a rest mass **M** that *also* has an imaginary value ($\mathbf{M}^2<0$). Then the observable mass-energy **E** of these particles becomes real and positive and is compatible with other energies in our Universe. Feinberg christened his hypothetical particles "tachyons" (from the Greek word for swift) for their characteristic that they always travel more swiftly than **c**.

A normal particle (or "tardyon" in Feinberg's terminology) has a velocity of zero when its mass-energy is smallest (when **E** is equal to **M**). Its velocity rises until it is slightly less than **c** when its mass energy **E** becomes large compared to its rest mass **M**. A tachyon (if such particles exist) would behave in an inverted way, so that when its mass-energy is smallest (equal to zero) it would have *infinite* velocity. When the mass energy **E** of a tachyon is made very large compared to the absolute value of its rest mass, it will slow down until its velocity is only slightly larger than **c**.

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This can perhaps be seen more clearly by considering some equations of special relativity. When any particle (tachyon or tardyon) has rest mass **M** and mass-energy **E**, it has a momentum **P** (in energy units) given by $\mathbf{E}^2 = \mathbf{P}^2 + \mathbf{M}^2$. For tardyons (normal particles) it should be clear from this equation that **E** cannot be less than **M** and is always greater than **P**. For tachyons, however, we have the peculiarity that $\mathbf{M}^2$ is negative, so that the energy equation becomes $\mathbf{E}^2 = \mathbf{P}^2 - |\mathbf{M}|^2$ or $\mathbf{P}^2 = \mathbf{E}^2 + |\mathbf{M}|^2$. This means that for tachyons **E** can be as small as zero (when $\mathbf{P} = |\mathbf{M}|$) and that **P** is always greater than **E** and cannot be less than $|\mathbf{M}|$. These quantities are related to the relativistic velocity β by the equation $\beta = \mathbf{P}/\mathbf{E}$. This tells us that when a tachyon has its minimum possible momentum $\mathbf{P} = |\mathbf{M}|$, it will also have its lowest possible mass-energy ($\mathbf{E} = 0$) and will have infinite velocity.

The theoretical work on tachyons in the 1960s by Feinberg and others, particularly Sudarshan and Recami, prompted a "gold rush" among experimentalists seeking to be the first to discover tachyons in the real world. They studied the kinematics of high energy particle reactions at large accelerators, they built timing experiments that used cosmic rays, and they probed many radioactive decay processes for some hint of tachyon emission. Although there were a few false "discoveries" among these results, all of the believable experimental results were negative in the decade or so after the initial theoretical work. Some cold water was also thrown on the tachyon concept from the theoretical direction when it was demonstrated (by physicist and SF author Gregory Benford, among others) that tachyons could be used to construct an "anti-telephone" capable of sending information backwards in time in violation of the principle of causality, one of the most fundamental and mysterious laws of physics. Tachyons were therefore metaphorically placed on a dusty shelf in the museum of might-be particles for which there is no experimental evidence, and there they have languished for the past 25 years. But this may now be changing; a new and growing body of evidence from an unexpected direction supports the possible existence of tachyons.

There is great fundamental interest in the mass of the electron neutrino (ν_e), because it is a leading "dark matter" candidate. Several very careful experiments have been mounted to measure its mass through its effect on the beta decay of mass-3 hydrogen—tritium. Tritium, with one proton and two neutrons in its nucleus, is transformed by the weak interaction beta-decay process into mass-3 helium (two protons and one neutron) by emitting an electron and an antineutrino ($^3\mathrm{H} \rightarrow {}^3\mathrm{He} + e^- + \bar{\nu}_e$) with an excess energy of 18.6 keV. This is the lowest energy beta decay known, and therefore the one which is affected most strongly by the mass of the electron neutrino.

If the kinetic energy of the emitted electrons is measured for a very large number of similar tritium decays, one

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finds a bell-shaped "spectrum" of energies ranging from essentially zero electron energy to a maximum of about 18.6 keV. This maximum-energy tip of the electron's kinetic energy distribution is called the "endpoint," and is the place where the neutrino is emitted with near-zero energy and where the neutrino's mass will make its presence known. When the endpoint region is made linear (using a plotting trick called a Kurie plot), then the straight-line dependence of the electron's kinetic energy takes a nose-dive just before it reaches zero, displaying the effect of neutrino mass.

Because of the relativistic relation of mass, energy, and momentum ($\mathbf{E}^2 = \mathbf{P}^2 + \mathbf{M}^2$) it is the mass-squared of the neutrino that is actually determined by the tritium end-point measurements. The mass-squared is allowed to vary from negative values (too many electrons with energies near the end-point) through $\mathbf{M}_\nu{}^2 = 0$ (the expected number of electrons with energies near the end-point), to a positive mass-squared (too few electrons with energies near the end-point), and this variation is used to fit the experimental data. The resulting fit is quoted with the measured value of $\mathbf{M}_\nu{}^2$ plus-or-minus the statistical error in the measurement plus-or-minus the estimated systematic error in the measurement.

At least five experimental groups have made careful measurements of $\mathbf{M}_\nu{}^2$, and several of these groups have published their results in scientific journals. The two most recent published values are:

Zürich (Switzerland)

$\mathbf{M}_\nu{}^2 = -158 \pm 150 \pm 103\ \mathrm{eV}^2$ (1986)

Los Alamos (USA)

$\mathbf{M}_\nu{}^2 = -147 \pm 68 \pm 41\ \mathrm{eV}^2$ (1991)

As the numbers imply, both groups find an *excess* of electrons with energies near the tritium endpoint. There have also been recent informal reports (but no further publications) from these and other laboratories, particularly a group at a well-known weapons laboratory in California, of measurements which continue to give negative values to $\mathbf{M}_\nu{}^2$ with even more statistically meaningful error estimates. I was told by one of the experimenters that if a similar result had been found with the same errors but with the *positive* of the determined value for $\mathbf{M}_\nu{}^2$, there would have been much publicity, with press conferences announcing the discovery of a non-zero mass for the electron neutrino.

OK, this is an SF magazine, not a scientific journal. We are not scandalized by the possibility that $\mathbf{M}_\nu{}^2$ is negative, indicating that the electron neutrino is perhaps a tachyon. In fact, we rather like the idea that a well known particle may routinely be breaking the light-speed barrier. Let us then suppose that the ν_e is a tachyon with an imaginary mass of say $i \times 12$eV. What are the physical consequences of this? The answer is disappointing. The tritium endpoint measurement is so difficult precisely because assuming a small neutrino mass (real or imaginary) has very few observable consequences. The "dark matter" implications are also nil. Since tachyons can have any mass-en-

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ergy down to zero and are never at rest they, like photons, cannot contribute to the excess of dark matter in the Universe.

The above-mentioned "tachyon anti-telephone" with its violations of causality is also essentially impossible to construct in practice. Neutrinos are fairly easy to produce (using an accelerator to create beta-decaying nuclei) but very difficult to detect. The only successful neutrino detectors use either neutrino-induced nuclear reactions (the Homestake and Gallex experiments) or hard neutrino-electron scattering (Kamiokande and SNO) to detect neutrinos with extremely low efficiency. But to use the possible tachyonic super-light speed of the electron neutrinos, ν_e's must have mass-energies comparable to or less than 12 electron volts. This is about 10^{-6} of the lowest neutrino energy ever detected, so neither of the above detection schemes can be used in this energy range, and there is no known alternative method of detection. Thus, even if the ν_e is a tachyon, the law of causality is safe from our tampering for the foreseeable future.

This brings us our second question: What new SF gimmicks are suggested by the possibility of easy-to-produce tachyons? I have a delightful answer. We can make a *tachyon drive*.

Consider the central problem of rocketry: how can one burn fuel at a high enough exhaust velocity to provide reasonable thrust without an unreasonable expenditure of energy. This is the dilemma that plagues our space program, and the solutions we have developed are not very good.

So let's consider a device that makes great quantities of $\mathbf{E} = 0$ tachyons and uses them as the infinite velocity exhaust of a "rocket." Within the constraints of the conservation laws of physics, we can make all the tachyons we want for free, provided we make them in neutrino-antineutrino pairs to conserve spin and lepton number. Momentum conservation is not a problem because we want and need the momentum kick derived from emitting the neutrino-antineutrino pair. This leaves us to deal with energy conservation.

The paradox here is that with a high-momentum exhaust of tachyons produced at no energy cost and beamed out the back of our space vehicle, the vehicle would seem to gain kinetic energy from nowhere, in violation of the law of conservation of energy. The solution to this paradox (as can be demonstrated by considering particle systems) is that the processes producing the tachyons must also consume enough internal energy to account for the kinetic energy gain of the system. Thus, a tachyon drive vehicle might be made to hover at no energy cost (antigravity!), but could only gain kinetic energy if a comparable amount of stored energy were supplied.

How could we arrange for an engine to produce great floods of electron neutrino-antineutrino pairs beamed in a selected direction? All I can do here is to lay out the problems and speculate. Neutrinos are produced by the weak interaction, which has that name because it is many or-

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ders of magnitude weaker than electromagnetism. Neutrino production of any kind is improbable. On the other hand, in any quantum reaction process the energy cost squared appears in the denominator of the probability, and if that energy is zero, it should make for a big probability. The trick might be to arrange some reaction or process that is in principle strong but is inhibited by momentum conservation. Then the emission of a neutrino-antineutrino pair to supply the needed momentum with zero energy cost would make the process go. A string of similar atomic or nuclear systems prepared in this way might constitute an inverted population suitable for stimulated emission (like light, correlated neutrino-antineutrino pairs should be bosons), resulting in a beam from a "tachyon laser" that might amplify the process and produce the desired strong beam of tachyons.

That's about the best I can do at the moment, for providing the scientific underpinnings of a tachyon drive for SF purposes. I think it's a nifty idea to which I will devote more thought. I just hope it survives the ongoing experimental measurements of M_ν^2 for the electron neutrino. Watch this space for further developments. ■

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There has never been a consensus in this country for free speech; only a lack of consensus on which speech to suppress.

Kelvin Throop's Guide to Political Correctness

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Robert J. Howe

DE GUSTIBUS

Harmon M. Gobilier stared out to sea and cursed his dead wife. His untenable position was Daria's fault, the cow. Gobilier almost wished he hadn't killed her; that she was here so he could watch her suffer the agonies of starvation.

The lifeboat had splashed down, then sank, near a desert island, on a deserted hemisphere, on a deserted planet. There would be no rescue, and soon, now that the boat rations were gone, he would follow them into oblivion.

All because of Daria. His family had warned him of the dangers of marrying out of one's class, naturally, but he had thought her an exception to the rule. She was young then, as was he, and she was thin; a slender wand of a woman with tremendous energy.

He shifted his weight and put more of his body under the makeshift sunshade he'd erected from his clothing and the remains of the emergency rations box. The skin over his prominent hipbones was raw from the gravel-like sand of the island. In a while he would drag himself to the water's edge and drink. Were it not for being marooned on a freshwater ocean, he would already be rotting under the blue-white sun.

He prided himself on his superb physical condition. He played squash in the winter months and sailed and golfed the rest of the year. He watched what he ate; on his forty-fifth birthday he'd gone on a strict regimen of low calorie foods four days each week.

But not Daria. It was the tastes of the lower classes. She insisted on natural fats and sugars in all her foods, putting Cook through the trouble of making several extra meals each day—even though Gobilier defied her to taste the difference. As she grew older, she increased in girth.

Gobilier closed his eyes and rested

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his face in his hands. Near the end, even the thought of physical contact between them repelled him. It had taken an effort of will for him to squeeze that flabby neck long enough to still her stentorian breathing forever.

A slight scraping sound made him look up at the water's edge. It took him a few seconds to pick out the floating shape among the sharply reflecting wavelets.

It was a huge aluminum-colored crate, perhaps two meters on a side, riding with its top just at the water's surface. Could it be more rations from the ship? Gobilier tried not to hope too much as he pulled himself to his feet. He waded into the water—it was like stepping into a tepid cup of tea—and examined the crate.

AD ASTRA CATERING SERVICES CM was painted in red letters on the polished metal surface, 750 UNITS. He stared at the letters, waiting for them to vanish like a mirage. This was beyond luck. This much food—if he ate it sparingly, who knew how long he could last?

The crate was too heavy to carry, or even to slide out of the water. Gobilier strained against the seaward side, managing to shift it less than a few centimeters up the beach. He was leaning against the rear of the crate, keeping it from floating back out to sea, when the solution presented itself to him.

He reached under the crate and turned it end over end toward the dry land. It was heavy, and his once-powerful muscles protested fiercely under the strain, but eventually he had the box high enough out of the water to ensure its safety.

He undid the seal, his hands trembling from exertion and excitement. The top of the box slid off smoothly, and he was looking down at hundreds of individually packaged meals in self-heating containers.

Daria hadn't managed to doom him from the grave, after all. Gobilier was not a religious man, but he was tempted to fall on his knees in thanksgiving for this boon. Only the unseemliness of the gesture stopped him.

He picked a meal unit at random and fired the heating strip. He set the unit on the sand and waited in pleasant anticipation. He would eat two meals each day—at worst a year's supply of food. It was salvation.

When he could no longer resist the scent of food rising from the container, Gobilier ripped the top off and dug into the meat and vegetable pie. Though still cold in the center, it was ambrosia. As he ate, he imagined the strength flowing back into his limbs.

He was almost finished eating when his glance fell on the cast-aside cover of the meal unit and the bright blue letters printed thereon. The taste of his meal took on a sickening familiarity as he read and reread the words:

LESS THAN ONE CALORIE PER SERVING. ■

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Grey Rollins

DARWIN'S CHILDREN

Illustration by Christopher Bing

The Crisium Observer *ran it on screen two, but there were no supporting articles, and none of the editorials mentioned it at all. The understated way in which the story was handled left more of an impression of gathering tension—of waiting for the other shoe to drop.*

The Earth-based news services, however, pounced on the story instantly. Within twenty-four hours, it was put before the entire modern human universe.

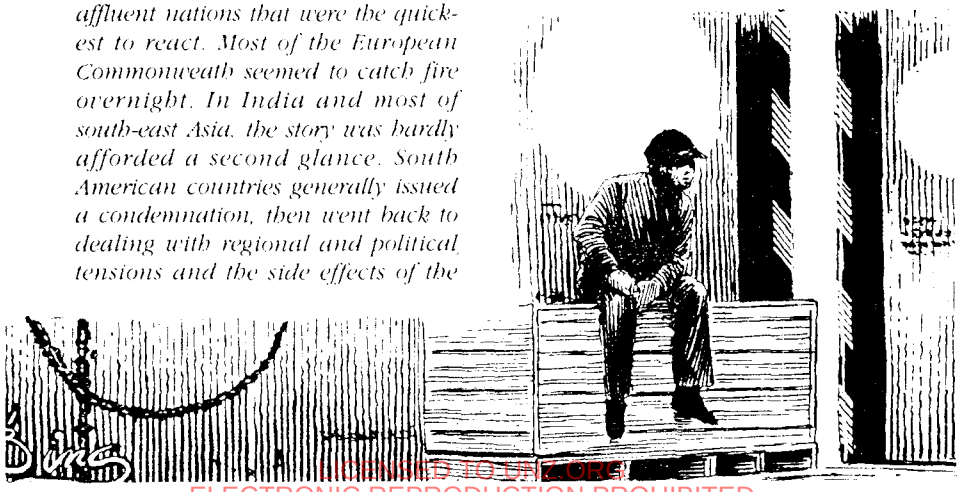
An economic map of Earth could have been drawn with great accuracy by noting the public outcry. . . or lack of it. Inevitably, it was the more affluent nations that were the quickest to react. Most of the European Commonwealth seemed to catch fire overnight. In India and most of south-east Asia, the story was hardly afforded a second glance. South American countries generally issued a condemnation, then went back to dealing with regional and political tensions and the side effects of the continuing drought in the Amazonian Basin.

North America convulsed with indignation and outrage. Protests sprung up spontaneously, across the United States, in large towns and small. A group, estimated at twenty-three thousand, marched in Washington, D. C., demanding that someone be held accountable.

That one woman should die was not remarkable.

That she should die of starvation was regrettable.

That she should die of starvation on Luna, the supreme bastion of high



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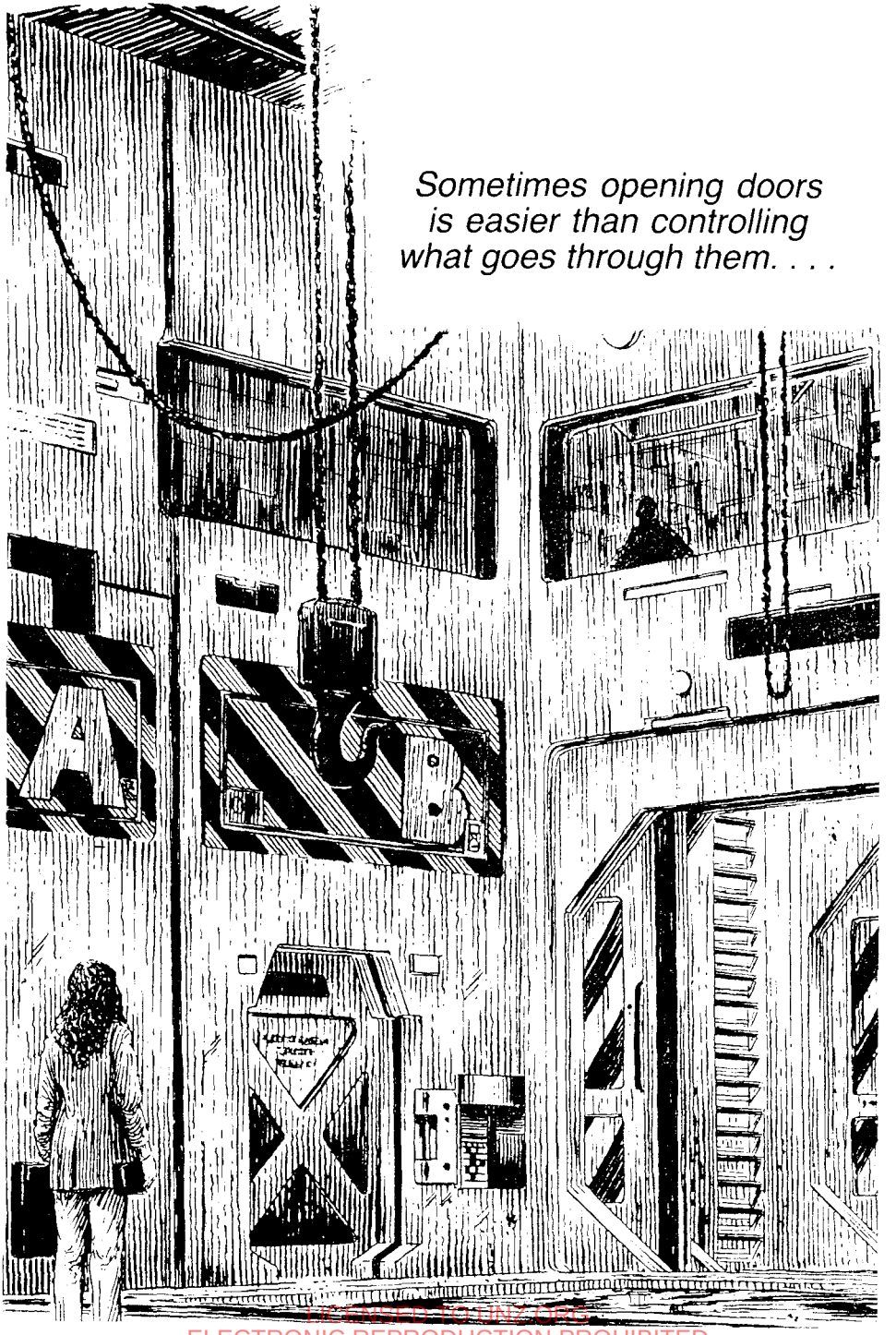

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technology and possessor of the highest standard of living in all of human space, was unacceptable.

Crises come, crises go; such is politics. But for the political center of gravity of Luna, to be a city *named* for crises seemed a little like tempting fate. For the thousandth time, Alan Lister wished that someone had shown the foresight *not* to name the city Crisium.

Or that he had shown the foresight not to run for commissioner.

He had first heard the name Emily Starnes in a briefing Wednesday morning by Tim Smallwood, an advisor who kept him up to date on things happening within the city. Smallwood's report had been brief; only that an Earth woman had died. No one had foreseen the emotional outcry that would result from Starnes's death. After all, a man from Ontario had died of a heart attack just two weeks before and the only difficulty had been finding next of kin.

Thursday was an entirely different matter, however. During the night in Crisium, the news had broadcasted across breakfast tables in the European Commonwealth. As Lister reached his desk, the story was following daybreak across the east coast of North America.

Lister's schedule had originally shown thirty minutes for routine paperwork, followed by an hour-long slot for a committee report on the feasibility of a Holmes Door between Crisium and New London; Hammond Kent, commissioner of New London, was to telelink in.

The office computer had shown all phone lines holding as soon as Lister had reached the office. Sighing, he had pushed the neatly stacked paperwork aside and punched the button to start taking the calls.

After the fifth call, it was clear that the results of the feasibility study would have to wait, and he postponed the meeting an hour. Forty-five minutes later he canceled it entirely. The stack of paperwork still had not been touched.

After a particularly trying interview with a reporter from *The Washington Post*, Lister pushed his chair back and rubbed his face vigorously. It was a given that things went wrong when he was least prepared to deal with them, and this morning had been no exception. He had not slept well the night before and though it was only late morning, he was already feeling drained.

"Anne?"

His office computer, hearing his human secretary's name, automatically opened a line to her; she worked from her home tunnel. "Yes?"

"Remind me to think up something dreadful to do to Tim. He didn't tell me that Starnes was penniless and starved. It makes all the difference in the world."

"We could put itching powder in the crotch of his surface suit," she suggested.

"Too kind."

She chuckled. "I'll keep him out of your way for a while. That will give you time to calm down."

"That's probably a good idea. Oh, and another thing. We'll need to up-

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[illegible] in the [illegible] the office. When I [illegible] Summers on hold [illegible] from some AP [illegible] right."

[illegible] hand. "That's a [illegible] is a senator, [illegible] problem right [illegible] probably have [illegible] right. Just the [illegible] you take con- [illegible] from the com- [illegible] judgment better [illegible]

[illegible] argue with [illegible] rolls over and [illegible]

[illegible] tempted to [illegible] personality mod- [illegible] with the stu- [illegible]

[illegible] fingers together [illegible] indicating [illegible] want to?"

[illegible] mopped his face [illegible] tempting some- [illegible]

[illegible] to one of many [illegible] her desk. [illegible] the heap right [illegible]

[illegible] you'll talk to [illegible]

[illegible] trifled with—his [illegible] column, "The Man In [illegible] of the *Crisium Ob-* [illegible] circulated widely on [illegible] well get it over [illegible]

[illegible] was replaced with [illegible]

"This is Alan Lister."

Rice chuckled. "I know who you are, Alan. I was wondering if I could get a comment from you on Emily Starnes."

"Edgar, at this point all I know for certain is that a woman died. I am deeply sorry, but until I know more about the circumstances, I'm not prepared to make a statement."

Rice cocked his head and gave a wily smile. "Come on, Alan! I can't print that."

Lister smiled tiredly. "OK, suppose I go on record as saying that the situation is under investigation."

"Better, but it's still awfully brief."

"Well, for crying out loud, Edgar, express my regrets or something. Fatten it up. Since when have you ever let my actual words stand in the way of what you thought I *should* have said?"

Rice chuckled again. "Seems to me that I recall once late last year when I did just that."

Involuntarily, Lister shuddered. "I remember."

"You really ought to learn how to handle the press."

"I will, I will . . . I promise I'll get to it just after I learn how to handle the political end of being a commissioner—probably about two weeks after I complete my term in office."

Staring blankly into space, Rice said. "OK, how does this sound? 'Commissioner Lister issued a statement expressing concern and dismay after hearing of the death of Emily Starnes. He has promised a full investigation into the circumstances of her death and has pledged to prosecute

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to the fullest extent of the law any persons who might be found to have harmed Mrs. Starnes.' "

"Sounds good. Go with it."

"Alan, you really ought to look into getting a PR flack."

"Why? So you could put words into his mouth instead of mine? I prefer the honesty of having you tell me ahead of time what I said."

Rice shook his head in wry amusement. "It's a wonder you ever got elected, Alan. On Earth, a politician who tells the truth doesn't stay a politician for very long."

"If you'll recall, that's what I told the voters. I don't intend to stay in but one term, so I can tell the truth."

Rice smiled as he reached out to break the connection. "I know. That's why I voted for you."

Lister allowed himself a tight smile as he watched Rice's image fade. "Anne?"

"Here."

"I want you to hold all calls for a while. I need to take a break."

"I told you to go on the offensive. You wouldn't listen."

"I thought it would blow over. People starve on Earth every day."

"Alan, if someone dies in a city on Earth, they can't afford to place blame. If they did, they'd find that the finger was pointing right back at them. But since this woman died here, they can safely blame us without—"

"That's a pretty smug attitude."

"Don't blame me, buster. I'm just explaining human psychology to you."

Lister subsided into an uneasy grumbling.

"Listen, you can complain all you want, but this is an emotional issue, not a logical one. It won't go away. They want a scapegoat to assuage their guilty consciences, and you're it."

"But we didn't make her that way! Do they expect us to bail out all of their people who can't cope?" he demanded.

"Yes," she said simply.

"Dammit, that's not what I meant, and you know it."

"Yes, it is what you meant, and yes, I do know it."

"But you haven't heard the unholy glee in their voices when they call up from Earth."

"I don't have to. I already know what they think of us and it doesn't surprise me in the least. Alan, the groundhogs are *glad* that this has happened."

"Anne!"

"It's true. And furthermore, I'm willing to bet you a raise that it's going to get worse before it gets better."

"Woman, assuming that you were to win, I'd be put through the wringer trying to justify the money. Just exactly what makes you think that you're worth so much?"

She snickered. "Two reasons. I'm always right, and I'm good in bed."

"Says who?"

"Says you," replied his wife. "At least you'd better, if you know what's good for you."

Jason Starnes was a tall man with broad shoulders and a face roughened by exposure to weather. His

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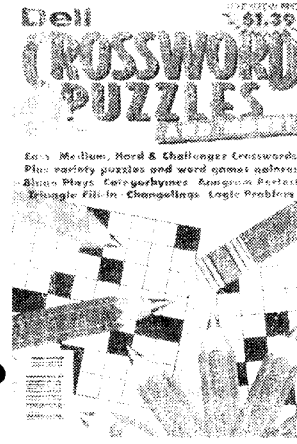
TANTALIZE AND CHALLENGE YOU EVERY MONTH



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fingers were blunt and strong; permanently calloused from years of splinters. He was toying with a pencil as he looked across his desk at the woman they had sent.

"Are you sure that you've got the right man?" he asked.

"No, sir," she admitted. "Not totally, or else I wouldn't be asking these questions."

He dropped the pencil and stood, turning to the window behind him, looking out across the parking lot to the pen where the backhoes and flatbeds were locked up at night. "Emily dead . . . it seems like . . . I don't know how to deal with that. Part of me still loves her, you know. At least, I once loved a woman by that name. By the time we divorced, that woman was gone and another had taken her place."

The policewoman said, "I'm not here to arrest you. We're just trying to verify her identity."

He snorted. "You just got done telling me she was my ex-wife. Now you're telling me that maybe she's not. Which is it?"

"We're trying to identify the body, sir. I need information that might help."

"You mean like moles, things like that?"

She nodded, but he was still looking out across the equipment yard, so she said, "Yes, sir."

"God, it's been six years. Sometimes it seems like only yesterday—other times it seems like a thousand years have passed. And now you want me to come up with . . ." He sighed. "OK. She had a thin scar about an inch long on the inside of her ankle. I forget which side."

She nodded. "Anything will help."

"There was a small nevus on her left hip. I remember it showed when I first met her. She was wearing a bathing suit at the time."

"Anything else?"

"Not that I can remember," he said apologetically.

"The New York police are cooperating with those in Crisium to try and trace her movements before she died. If you know anything about where she went after you divorced, we might be able to help them out from this end."

At last he turned around, facing her squarely. His expression was unreadable. "Emily had a problem with alcohol. It's why we divorced. She went from drinking only at parties to hiding bottles of vodka under the kitchen sink. She would be gone for days on end. I went out of my mind with worry. We tried one of those places that claimed they could detox her. Then another. She ran away from the third one. Two months later she came home with a long, ragged gash on her arm . . . rang the doorbell at three in the morning—"

"Wait a moment. Did that cut leave a scar?"

He shook himself, as though coming back to reality. "I wouldn't know. We were divorced as soon as I could hurry the lawyers through the paperwork. I couldn't stand it any more."

The policewoman nodded and made a note. "I understand. Well, it's one more thing that we can check

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out. Do you know where she was staying after the divorce?"

His face went blank again. "Anywhere and everywhere. I heard that she stayed with her parents for a while, but I'm not sure about that. We didn't talk much after the divorce. They blamed me for her problem."

"How so?"

He gestured towards out the window. "I started as a carpenter. Then I became a site foreman. Later on I bought out the man I worked for and built the biggest contracting service in the state. That took a lot of my time and a lot of my energy. I thought she understood, but it turned out that she didn't. She wanted her ship to come in right then, meaning instantly. When it started to look like it might be a few years, she turned to drink." He took a deep breath. "Like I said, her parents blame me."

The policewoman didn't know how to respond to this, so she simply nodded.

"You know, the funny thing is, I think we could have made it if we had been born a little later."

"Really?"

"Yeah. This is all too big to leave now, but if I had less invested in it, I'd be gone. I'd go to Luna. That's the place for men like me these days."

"How would that have saved your marriage?"

He gave her a sad smile. "I once promised her the Moon. . . ."

The cart was small and carried only two tanks. One was pressurized air, the other contained a solution of Neotoxin. One of the rear wheels emitted a repetitive *nit-reek, nit-reek* as the man pulled it along behind him. When he got to the lift at the head of the shaft descending to the unfinished new level, he stopped and produced an actual hard-copy letter for the man guarding the lift.

"They said you'd want to see this," the man towing the cart said.

The policeman glanced over the letter, then looked up at the other. "You're Hank McLuan?"

"Yes." He reached for the slim wallet that contained his identification.

The policeman waved his hand. "That's not necessary. All I needed to see was this," he said, waving the piece of paper. He pocketed it. "I'm glad I don't have your job."

McLuan shrugged. "Someone's got to do it."

"Still . . ."

"I'm sure there are days when you have to do something unpleasant."

"Yeah, but—"

"Let's get going. The sooner I get this done, the better we'll all feel."

The policeman turned and unlocked the steel mesh that served as the door to the lift cage. McLuan tugged the cart in and turned as the policeman got in behind him. The ride was short; they only had to drop fifteen meters. The floor of the cage tilted slightly when it hit the uneven rock of the new corridor's floor, causing the cart to bump against the heavy woven wire that made up the side of the lift cage.

McLuan pulled the cart off the side of the cage and stepped out onto the bare stone floor of the unfinished new level. He looked back at the police-

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man. "You're not coming with me?"

"No."

"They said you'd show me where they found her."

He gestured to the right. "Go up the tunnel about thirty meters, maybe a little more. Anyway, it's the first left. Take that. Ten meters or so and you'll see a little cul-de-sac off to the left. That's where she was."

Somewhat amused by the policeman's squeamish refusal to accompany him to the site where Emily Starnes's body had been found, McLuan asked maliciously, "Did they tell you why I'm here?"

"To spray for something," he said, gesturing at the tanks on the cart.

"You know what she had?" McLuan persisted.

"No . . . what?" he asked hesitantly.

"Lice. Lots of 'em. From what I hear, she was covered from head to toe."

The policeman shivered involuntarily. "God, and we try so hard to keep it clean up here."

"We've gotten used to it," McLuan agreed. Then he continued, "It's pretty gross when you think about it. Someone who actually has bugs living on her body. Crawling, biting . . . imagine how that must feel."

The policeman laughed nervously. "I'd rather not. You just make sure that you do a good job, OK?"

"Never fear. I don't like bugs any more than you do."

"Hit the button on the wall when you're ready to come up." The cage lurched into motion, taking the policeman back to the still sanitary floor above. Before the stone ceiling cut off his view, he caught one last view of McLuan walking up the corridor, framed by the rough stone walls, with the naked light bulbs strung along the corridor glaring down on the two tanks in the cart that squeaked along behind him.

Even after he could no longer see McLuan, he could hear the cart echoing, *nit-reek, nit-reek.*

"OK, Anne, who's next?"

"Lewis Cantner."

"Have I done something particularly horrible to you that you should unleash him on me?"

"Well, you did leave a sock on the floor the other night when you came to bed," she said thoughtfully.

He shook his head sadly. "You're a cold woman, Anne."

"I'll send your buddy right in," she said, winking at him as her image faded.

She had instructed the computer at their tunnel to tell the one in the office to open the portal to the waiting room. Faintly, Lister caught Anne's last words as her image in the waiting room told Cantner that Commissioner Lister would see him now.

The man who entered was big, in a beefy way which told of comparatively recent immigration from Earth. Had he been on Luna long enough, the unused muscle mass would have melted away and he would more closely resemble those who had been on Luna their entire lives. Indeed, Cantner had only been in Crisium for nine months, but in that short time period, he had established a widespread reputation for having a short

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temper. His personality had earned him many enemies, among them Alan Lister.

Cantner forged forward, hand outstretched. "Hello, Alan."

Lister rose and took the other's hand. With his free hand, he gestured at the visitor's chair. "Have a seat, please."

After taking possession of the chair, Canter came straight to the point. "I wanted to know what you intended to do about this Emily Starnes situation, specifically about the Door."

"I'm afraid I don't follow you," Lister said, in an effort to draw him out.

"Well, clearly we don't want her kind up here, but I've heard that you're considering raising the passenger rates through the Door to keep more like her from coming through."

Lister blinked in surprise. "So far, we have not decided whether to do anything at all, much less narrow the options down to raising the rates."

"That's what I was told," Cantner persisted.

"I won't bother asking where you heard it, but I can assure you that we have made no decisions—"

"I just want to make sure that you don't make the *wrong* decision."

"Somehow I get the feeling that we aren't talking about the same thing."

Cantner sat back in his seat, rubbing his jaw and glaring at Lister. Then he said, in a precise, cold tone, "Let me see if I can make it clearer, then. As you are aware, I am the chairman of the Crisium Business Group."

"I understand that." In fact, it was hard not to be aware of it. Rumor had it that Cantner had bought votes when the position came open shortly after he had started his restaurant in the Core of the third level. Many people were still bitter about it.

"We are concerned that you might do something . . . hasty. Something ill-conceived. We are fully in sympathy with any attempts to keep out those who have nothing to offer, but we don't want anything done that might curtail the tourist traffic."

Lister nodded as the figurative light went on over his head. "You're afraid that higher rates through the Door might cut the number of shoppers who come through from New York to buy here . . . or eat."

"Precisely," Cantner said, rubbing his hands together.

"I see." Lister leaned back and stared at the ceiling contemplatively. After a few moments, his eyes dropped to lock with Cantner's. "As I've said, no decisions have been made yet. Supposing I ask you, as a favor, you understand, to get the Crisium Business Group together and solicit suggestions from your members as to how to address this problem."

Cantner's eyes narrowed. "You'll take action along whatever lines we suggest?"

"I didn't say that. However, if all of you put your heads together, you might be able to come up with a solution that might otherwise escape us. I'd appreciate some help thinking this through. We will need to find a solution that will serve all our needs, and you and your fellow businessmen and women just might come up with the answer."

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It took a few more minutes, but finally Lister was able to escort Cantner out of his office. He closed the door as he came back in and collapsed in his seat. "Anne?"

"Yes?"

"Did you listen to what our friend Lewis Canter had to say?"

"Yes."

"Got any response?"

"Not right off the top of my head, no."

"The damnable part is that the man is right. We're pulling our own weight, but if my memory serves me, tourism accounts for forty percent of our incoming money."

"Thirty-eight point six percent," she told him. "That's up to date through last week, according to my computer."

"Still, we don't dare do anything that will damage that income. We need it too badly."

"I'm not arguing with you, Alan. I agree totally. Unfortunately, we're caught between a rock and a hard place. If we start trying to care for people like Emily Starnes, then we'll have to siphon off some of that currency that's coming up from Earth in the form of taxes, fees, or whatever. Then we'll need more people spending more money to offset the amount that was siphoned off. Those people will, in turn, place an even greater strain on our resources and we'll need more money to offset—"

Lister held up his hands in protest. "You don't have to hammer it in."

"I just wanted you to understand the full hopelessness of the position you're in," she said helpfully.

"With friends like you . . ." he began, then allowed his voice to taper off.

"Ah, but I'm your wife," she responded. "That's a separate category from either friends or enemies."

"Yeah," he retorted, "with the worst aspects of both."

A woman in a smartly tailored business suit stood on the New York side of the Holmes Door, near the threshold. She stood next to a huge lathe on a wooden palette, resting one hand on it possessively. Her attention, however, was on the other side of the Door.

The raw rock walls of the Crisium terminus contrasted sharply with the New York station, which had smooth white walls and was floored with tile. Indeed, the floor on the Lunar end was the only smooth, flat surface in the chamber, but even it was bare stone, dark and ancient. The New York end was much larger and airier than the Crisium terminus, which was only about the size of a basketball court.

The Door itself was anticlimactic. The threshold was mapped out in diagonal red and yellow stripes, but the singularity had no visible side effects. No shimmering, no haze . . . nothing.

A freight handler approached, interrupting her scrutiny. He was carrying a pair of leather work gloves. He tucked the cuffs into his back pocket. "Ready to go?"

"I suppose so," she said, in an excessively casual manner.

He was reading the bill of lading attached to the side of the lathe. At

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the tone in her voice, he glanced at her. "First time across?"

"Well . . . yes."

"Want to ride or walk?"

She frowned. "Ride? Ride where?"

He grinned. "Across the threshold. Some people would rather take the gravity change sitting down."

"I . . . don't know. I didn't know I had a choice."

He surveyed her rather formally cut business suit, then shrugged. "Since you're wearing a skirt, you might rather ride across."

"Wait a minute. I'm not following something. You're saying I should ride across the room? It's not that far."

With an effort, he suppressed the urge to remind her that the room happened to be a quarter of a million miles long. She didn't strike him as the type who would appreciate the humor. "It's not the distance, it's the gravity change. It makes it tricky to walk across the threshold of the Door."

She looked doubtful. "What is this? A gimmick so that you can charge me more money?"

"We don't charge people who want to ride."

"Then why?"

He considered for a moment. She didn't look stupid. Maybe she was simply one of those people who ignored things until they were confronted with them. "It's a question of balance. It's *real* easy to fall when you cross those lines, no matter how good you think your balance is."

He reached out, grasped her shoulder, and gently pushed. Reflexively, she threw out her arms to counter the offset. "Hey! What are you doing?"

He grinned. "What you just did," he held out his arms to demonstrate, "makes good sense on Earth, but it will get you in trouble going through the Door."

Her eyes narrowed as she tried to follow. "I was just trying to get my balance back."

"Sure. And it works just fine . . . here. But it'll throw you on your face if you do it going through the Door."

She pointed over his shoulder. "*He* just walked across," she said accusingly.

The handler glanced back to where she was pointing. "That's Jerry. He works here, so he gets lots of practice. I didn't say it couldn't be done, it's just that the first couple of times through can be tricky."

Her facial expression took an obstinate set. "You're telling me I don't know how to *walk?*'

He sighed. "Be my guest. Walk across. Just give me a second to get a mat so you don't hurt yourself, OK?" With that, he jogged over to the wall next to the Door where several thick blue mats leaned against a counter. He took one and tossed it across to the Lunar side of the red and yellow stripes. Then he beckoned to her.

She walked resolutely over to the threshold and stepped across. Her leading foot immediately felt lighter. When it touched the floor, her weight didn't register as being heavy enough. In a deep-seated, animal part of her brain, she felt as though she must be falling backwards. Instinctively, she

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leaned further forward to put more weight on that foot. Suddenly, there was less of her body being held back by Earth's gravity and she felt herself pitching forwards as Earth relinquished its grip on her.

She fell face forward onto the mat.

Frowning, she rolled over and sat up. "You're not going to laugh?"

The handler shook his head. "Nope. Happens all the time. Some people even do it for fun, like a carnival ride. They'd flop back and forth all day if we'd let them."

She accepted his proffered hand and got to her feet. "I think once was enough for me, thank you."

"Just be careful on your way home." He hooked a thumb at the lathe, still on the Earth side of the threshold. "Give me a second and I'll get your palette over here."

As the handler crossed back over the threshold a Lunarian woman appeared at her shoulder. "Terry Woods?" she asked.

Terry turned. "Yes."

"Hi, I'm Barbara Couts. They wanted me to meet you and guide you back to the office."

"They gave me directions," Terry said, her hand reaching for the pocket of her jacket. She pulled out a piece of paper with scrawled directions and a crooked line on it.

Barbara glanced at it, then smiled. There was a hint of condescension in the smile. "Here, take this instead." She pressed a flat plastic card into her palm.

"What's this?"

"Press the logo."

She did so. A sudden burst of swirling color startled her so much that she dropped the card. She bent and picked it up. "What was *that?*"

Barbara said, "Don't just jab it. Hold it in."

Instantly, a holographic map of the city surrounded her hand. Two tiny points of light glowed, one blue, one white.

"The blue one is the office. The white one is you . . . actually the card. You can find your way to our office from anywhere in the city with that. Since the map's three-dimensional, it's a whole lot better at telling you when to change levels than instructions on a piece of paper."

"That's pretty neat," Terry said, as she handed it back.

Barbara waved her off. "Keep it."

"It must be expensive."

Barbara shook her head. "We give them away as a promotional gimmick. It's not an accident that it's got our logo on it."

After staring at it for a moment longer, Terry slid it into her pocket. "Thanks. Frankly, I've always wondered how you people keep from getting lost."

Barbara shrugged. "Why should we get lost? You get around in New York, right?"

"Sure, but—"

"New York is stacked a lot deeper than Crisium is. We're only eleven levels down, not counting the new level, but your skyscrapers go up and up and up."

Terry started to say that it was different, but as soon as she reached for the exact reasons why, they melted and flowed between her fingers. Si-

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lently, she walked beside her guide as she tried to come to grips with the elusive thought.

An exasperated sigh brought her out of her reverie. "What's wrong?"

In reply, Barbara pointed at a discarded paper cup on the floor in front of them. *"That!"*

"The cup?"

"We never had a problem with trash up here until they opened the Door. Now they earmark a percentage of the revenues from the Door just to cover the trash detail. It's disgusting."

To Terry, she seemed to be overreacting. After all, it was only one cup. Granted, it shouldn't be there, but she couldn't fathom the depth of the revulsion in her companion's voice.

Without saying anything, she bent and picked up the cup as she passed. "Is there somewhere I can put this?"

"See that slot in the wall? The one with a blue border?"

As they passed, Terry dropped the offending cup in the hole. "Is one cup really that bad?"

Barbara said, "We were on our way to being a disease-free society. Screening, plus the built-in quarantine of the shuttle trip allowed us to trap most of the germs coming up from Earth. It was rare for someone to have the flu." She gestured back at the trash slot. "Then the Door opened. Suddenly, we have this tremendous influx of germs and filth, and we're losing productivity to sickness again. Most of it is transmitted directly from people coming through the Door, but some of it is due to unclean habits. Much of medical history is nothing but learning that hygiene counts."

"I pass stuff worse than that every day and I don't get sick," Terry protested stiffly.

"Not a sniffle? Not a persistent runny nose and cough every winter?"

"Well, sure, but everybody gets those."

Barbara shook her head. "Not here, they don't." Then she snorted and added, "Or didn't, anyway."

"You're serious, aren't you? How long since you've had a cold?"

"I was born here," Barbara said, as though that explained everything.

"What's that mean?"

"That means I've *never* had a cold."

"They can give you shots that—"

"Give you immunity," Barbara finished for her. "Right?"

"Well, yes."

"Have you had them?"

"The shots? Yes."

"Did they work?"

"Well, I still caught a cold. They said that the bug had mutated and that the vaccine wasn't effective against the new version."

"I rest my case," Barbara said simply.

"Do you have to be so . . . so . . ."

"So hard-assed? Yes we do, because if we don't watch out for ourselves, it's a cinch that Earth won't do it for us. You people can't take care of yourselves, much less anyone else."

"Now, wait just a minute, Barbara! I haven't done anything to deserve that kind of attitude from you!"

"Maybe not you personally, but everybody here in Crisium has had just

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about enough of Earth's self-righteous condemnation. From where you sit, life up here doesn't look all that different from the way that you live. But let me tell you something, try it for a year then look back at Earth and tell me that you'd go back. There's a huge difference—*you* just can't see it!"

They had stopped, facing each other on the sidewalk next to the slidewalk. Barbara's fists were clenched. Terry said quietly, "I can see that we're not off to a good start, Barbara. Would you prefer that I turned your account over to another one of our staff?"

Her calm tone seemed to reach the other woman. "I apologize. It's just that we've been taking a lot of heat over Emily Starnes and I . . . we all are . . . a little quick to react."

"If I've upset you, I'm sorry. I guess I just didn't realize how important this topic was to you."

Barbara gave her a strained smile and resumed walking. "It's a siege mentality. I haven't been personally attacked and you yourself haven't done anything to threaten me. It's just that we're reaching a stage in the game where we're class enemies, regardless of whether we as individuals want to be."

"That's sad," Terry said, retreating into generalities while she tried to work out what to say next.

Inside her head ran the litany: *The customer's always right . . . the customer's always right. . . .*

That evening Lister walked into his tunnel feeling weary and defeated. "Anne?"

"In here," she called from her office.

He leaned against the frame of the portal. "Babe, I think this Starnes woman is likely to be the death of me."

"I hope not. Eating supper by myself is not on my list of favorite things to do." She rose from behind her desk and wrapped her arms around him. "Besides, I have other uses for you."

"It seems that a great many others have uses for me, too. Most of them want to use my hide for a dart board."

She stepped back and eyed him critically, then shook her head. "Nope. You're too skinny. All you'd have to do is turn sideways and they'd miss. It'd be like trying to hit a piece of paper edge-on."

He laughed and tousled her hair. "So that's what I've been doing wrong! I've been facing the screen all day and taking hits like crazy. Tomorrow I'll just sit sideways."

"That's right. Give them a view of your noble profile."

"I wish it were that simple. Unfortunately, like you said, to Earth this is an emotional issue—to us it's a logical one. You can't fight emotions with logic."

"Huh!" she snorted. "You can't fight emotions with *anything*. If you counter with your emotions, the whole thing just gets worse."

"One way or another, I need to find a solution. It would help if I had some perspective as to why Emily Starnes ended up the way she did."

"You mean poor?"

He nodded. "Somehow or another, there's got to be a reason."

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"But there are lots of poor people down there. Each of them has led a different life—has a different reason for being poor."

Alan shook his head. "Any time you have that many people in a similar condition, there has to be a common factor. You just have to be smart enough to find it."

She shrugged. "The economy is headed down and the politicians don't seem to want to do anything about it."

"Too simplistic," he said.

"And politicians have always been worthless," she admitted as an afterthought.

"Hey, watch it! You're married to a politician, you know."

She smiled and kissed his cheek. "The voters put you into office, not me."

"If I don't come up with an answer for this problem, those same voters are likely to make my life pretty miserable."

"Nope," she assured him. "That's my job."

Terry Woods flopped into her office chair, tilting it back as far as it would go. She leaned her head back, closed her eyes, and massaged her temples with her fingertips. It was late afternoon and the setting Sun glared through the window, exacerbating her headache.

A soft knocking sounded. "Anybody home?"

Her eyes popped open. "Hi, Herb . . . no, nobody's home."

Herb Withers, her supervisor, ambled over and sat in the chair across from her desk. "Something wrong?"

"Yeah, those people in Crisium are assholes."

"Problems with the account?"

Terry shrugged. "I hope not."

"Why don't you tell me about it, instead of making me drag it out of you."

She sighed. "The lathe's up there. No problem with that. It's the people. Did you know that they actually feel like *we're* the problem?"

He scowled. "I'm missing something here. What kind of problem are we talking about? Did you piss somebody off? Do I have to go up there and kiss somebody's ass to keep the account? Exactly what *is* the problem, Terry?"

"Them! All of them! They're so . . . *rude!* Just because I'm from Earth, they immediately assume that I'm subhuman. *They* are the only ones who are fit to walk those hallowed halls." She laughed bitterly. "I see the expression on your face, Herb! You think that I did something wrong, don't you?"

He arched one eyebrow. "The thought had crossed my mind."

"There was a paper cup on the ground." She snorted. "Excuse me . . . floor. There was a cup on their sacred floor. A piece of trash. She . . . Barbara, the woman they sent to meet me at the Door, got all bent out of shape about the cup. One lousy cup, for God's sake! Herb, from the way she acted you'd have thought that cup was the last straw. The end of civilization as we know it."

"I take it you didn't enjoy your first

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visit to Crisium," he offered.

She didn't hear him. "Those people have *attitudes*, Herb! And after all we've done for them!" She shook her head. "We paid good money—our taxes—to get them started up there, and they act as though they did it all themselves. They take us for granted, I'm telling you."

Her supervisor methodically cracked each knuckle on each finger on both hands before answering. "Are you telling me you want me to give the account to Casey?"

There was a long silence before she replied. "I hate to say yes, because those people are buying machine tools as though their lives depended on it. In the last six months they've bought almost as much as all of my other accounts combined." She grimaced. "Dammit! Yeah, give 'em to Casey. I hate to lose them, but I don't think I can talk to those people again without losing my temper."

Herb took a deep breath and let it out slowly, then pushed up out of the chair. He looked down at her. "Frankly, Terry, I'm a little disappointed in you."

She nodded ruefully. "Yeah, I know. Tell Casey I didn't yell. I didn't do anything that he'll have to undo when he talks to them."

He nodded. "I'll tell him." He walked to the door, then paused and looked back at her, one hand on the door frame. "You said that they were buying stuff as though their lives depended on it." He fixed her with narrowed eyes. "Had it occurred to you that it just might be the literal truth?"

* * *

The freight handler stood next to the counter, slapping his leather gloves against his thigh, simply because he enjoyed the popping sound they made when they hit. He had just arrived at work on an overcast morning with rain forecast.

His boss, sitting behind the freight counter, surveyed the computer screen, then looked up. "Looks like it's going to be a slow day."

The handler grinned at him. "Good. Does that mean I can have the day off?"

The man behind the counter scowled. "You're lazy enough as it is."

"Well, then give me something to do."

"All right. You see that box over on the Luna side?"

"Which one? The white plastic one, or the wooden crate?"

"The white one."

"Sure, I see it. Want it over here?"

The man behind the counter's mouth twitched. "Yeah."

"No problem."

Still slapping his leg with the gloves, the handler hopped lightly over the threshold of the Door and approached the white plastic box. It was long and narrow, only about a foot and a half deep. Briefly, he wondered if it was a trick. Perhaps it was full of gold bullion or something. Something really heavy. He gave it an experimental heft by lifting one corner a quarter inch. No problem.

He pulled his scanner from the holster on his hip, pointed it at the bill of lading, and squeezed the trigger. It beeped once to tell him that the box was cleared and ready to go. It was

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on a low, wheeled cart which made it easy to move.

He pulled it across the threshold and parked it next to the freight counter. An old man was waiting there. The man behind the counter had the old man sign a hard copy form, then nodded to two young men in suits who were standing back a respectful distance. They came forward, gently lifted the box, and took it away. The old man followed them, walking slowly.

"Know who that was?" the man behind the counter asked the handler.

"Who was it?"

"The old man was Emily Starnes's father."

The handler turned back and watched as the man shuffled away. "Really?"

"The box is her casket. She's coming home."

"How about an easy one?" Anne asked.

Alan eyed her image suspiciously. "How easy is easy?"

"Well, after fending off reporters and the police chief and various special interest groups, I thought you might like to see a friendly face."

"That still doesn't tell me who it is," he observed.

"Hammond Kent."

Involuntarily, a grin spread across his face. "The one honest politician in the known Universe."

His wife arched one eyebrow. "Oh? Are you saying you're not honest?" she teased, but before he could reply her face was replaced with that of the commissioner of New London.

"Hammond, how are you?"

"Doing well, but Anne tells me that you aren't."

Lister nodded ruefully. "This Emily Starnes thing is beginning to wear on me."

"I expect so. Listen, I'll get right to the point because I know you're just dying to get back to all those reporters. You canceled the meeting yesterday about the Holmes—"

Lister passed a hand over his face. "Don't remind me. Yesterday was not a good day. When's a good time for you? We'll set this up at your convenience."

Kent's image held up his hands. "Not so fast, Alan. I'm not sure I want a Door open between New London and Crisium right now."

"Meaning you don't want to have someone like Emily Starnes show up in New London."

"Better thee than me," Kent said. "I've got three business groups on my back who want a Door open between New London and Crisium. They all want a crack at that easy tourist money that's flowing up from Earth. On the other hand, I've got citizen's groups telling me no way—look at what's happening in Crisium—we don't want that here."

"I don't blame them. It disgusts me to walk down the corridors here and see all the trash that the tourists leave behind. To them, this is just an elaborate amusement park."

"So what are you going to do about it?"

Lister grimaced. "I don't know yet. All the responses I've thought of so far are either too much or too little.

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Either I end up keeping everybody out, or I let everybody in. I need some middle ground."

"I've got the advantage there. I'm not tied to the politics of any one country on Earth, so I'm free to set my own laws and enforce them as I choose."

"So why don't you want a Door?" Lister chided. "You could exclude indigent people if you wanted to."

"Let's just say that I believe this to be the tip of the iceberg. I think I could handle the current set of problems, but somehow I don't think this is the end of it."

"Care to clue me in on what to expect?"

Kent shrugged. "Just a hunch so far. I'll let you know if my paranoia takes on a definite shape."

"OK. Well, in the meantime I've got an open Door and an open door policy to go with it. I'm beginning to think the Door is more like Pandora's Box."

"Keep in mind that the last thing out of Pandora's Box was Hope."

"Yeah, but look at all the nasty things that came out first."

Edmund Tracey, six years old, turned from the evening news. "Mom?"

"Yes, honey?"

"Is Emily Starnes famous?"

His mother glanced at the screen and saw the reporter standing in the foreground speaking earnestly towards the camera, while a white box was being slid into a hearse in the background. "She is now."

"Is that why she's on the news?"

"She's famous because she died up on Luna, Eddie."

"Does everybody who dies on Luna get to be famous?"

"No, she's on the news because she was poor."

Edmund thought this over for a moment. A frown appeared on his face. "I thought only rich people got to be famous."

His mother gave up on the romance novel she was trying to read and put the Electrascroll aside. "You don't have to be rich to be famous. Emily Starnes is famous because she *wasn't* rich."

"I don't get it."

"She's famous because she starved to death in Crisium. That's a town on Luna."

Her son nodded solemnly. "I know."

"Well, the people who live in Crisium are mostly pretty rich. Everybody wants to know why they let her starve to death when they had more than enough money to feed her."

He glanced back at the screen just as the image of the reporter was replaced with an advertisement for a credit card. "They were bad, huh?"

"Who was bad?"

"The people on Luna."

The subtleties of the situation were beyond his comprehension, so she took the easy way out. "Yes, honey, they were bad. They shouldn't have let her starve."

A complex issue thus resolved to a simple formulaic response, Edmund turned back to watch the commercial. Quick flashes of a smiling, well-dressed couple dining out, playing

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golf, walking down a beach at sunset, making a purchase in the Atrium in New London. . . .

On the third day after the story broke, picket lines appeared on the pavement outside the New York terminus of the Door. By midday, police were called in to restore order. A businessman on his way to a meeting in Crisium had been beaten and the protesters were openly threatening others who were trying to conduct legitimate business.

Battle lines were drawn and it took tear gas and capsaicin to disperse the crowd. Three fled into the terminus building to escape the gas. Before anyone could stop them, they leaped over barriers and sprinted towards the Door into Crisium. On crossing the threshold of the Door, two of the protesters stumbled; one fell. He rolled to his feet and scrambled to catch up with his comrades. They were gone before anyone could react.

A concerted effort to locate them failed; there was no organized plan for finding fugitives in Crisium.

Thirty minutes later, an anonymous caller claimed that the three men had been planning the unauthorized jaunt from the beginning and that they had a bomb with them. The caller identified the men as members of an organization named The League For The Homeless, dedicated to easing inequities in income and alleviating conditions faced by the poor.

Citizens in Crisium were horrified. Those who had been born on Luna reacted most strongly; if a bomb were to explode in any pressurized part of the city, especially near the surface, depressurization could result and innocent people could die horribly.

All traffic through the Door was halted for six hours. When it became evident that the three men were not going to be found quickly, metal and chemical detectors were set up and travelers were individually screened and searched before being allowed to pass through the Door.

Samuel Watts, the chief of police in Crisium, rubbed his rough, calloused hands together as though they were cold. He shook his head. "Alan, there isn't much good news. We're at a disadvantage because dirtside police departments resent us. They're slow to cooperate. From their point of view, we're a bunch of effeminate sissies who don't know what it's like to run a *real* police department with real crimes and real officers."

Alan Lister held up his hands placatingly. "I know, I know. We've been through all this before. Just give me a report."

"I've verified that there were only three. For a while it looked as though there might be five of them, but I've talked to enough eyewitnesses that I'm back to three again. We know that they headed right once they got into the corridor outside the Door, towards the Core, but after that they vanished."

Lister steepled his fingers. "Vanished? How did they manage that?"

Watts gave him a sour grin. "Probably by slowing down to a normal walking pace. They weren't wearing

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anything remarkable. None of them had antlers on his head. The only thing that made people notice them was the fact that they were running. If they stopped running, then they would just blend into the scenery."

"So, as far as you know, they were headed into the old part of the city?"

"The Core, yeah. I've got two people who saw them go right when they hit the corridor. It's only about ten meters to the ramps to the other levels. They could have gotten most anywhere in the city inside of ten or fifteen minutes."

Rubbing his face in a futile effort to stir up his mind, Lister finally said, "How seriously do you take this anonymous caller?"

"Meaning, do they actually have a bomb? Honestly, I don't think so. I think that they just ran inside the terminal to get away from the tear gas, saw the Door, and kept right on going. On the other hand, I can't prove that they don't have one, and I'd like to play it safe."

"How safe?"

"Curfew at the least. If possible, I'd like to conduct a tunnel-by-tunnel search for these guys."

"That's pretty drastic. We've got law-abiding people out there who need to go on with their lives."

"We've got three guys out there . . . somewhere, who might, just possibly, have a bomb that could take the lives of some of those same law-abiding citizens."

"If, and I say *if* they have a bomb, what's our worst case scenario? Where would they take it?"

"Anywhere we're closest to vacuum. Our weakest points are the spaceport and the locks leading out to the surface. There's one place where level one is within just a few meters of the surface. They could do a whole lot of damage there if they knew where it was, but the spot's not marked—it's just a normal corridor. We'll assume that they don't know about that."

"There's not much traffic at the spaceport since the Door opened," Lister mused aloud. "I could order that closed off entirely without inconveniencing too many people."

"That'd leave the air locks," Watts observed.

"There's not a lot I can do about them. There are too many people who have perfectly good reasons to go out on the surface."

"We could set up search points at approaches to the locks, just like at the Door."

"God, I hate to do that."

"Do we have a choice?"

After a moment, Lister said, "OK, I'll let you have the curfew and control of the locks. We'll close the space-port for a few days."

"What about the tunnel search?"

"Can you guarantee results?"

The police chief almost said yes, then thought better of it. "No."

"I didn't think so. I can't let Crisium be turned into a police state, Sam."

"No, I guess not. Let's just hope these guys turn up and tell us it was all a joke."

Anne was unusually quiet that evening at dinner. Alan allowed her silence until she brought out dessert.

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Unable to restrain himself any longer, he asked, "Is something wrong, sweetheart? I mean, I know we've got three men loose in the city who might be terrorists, but it's not like you to be so quiet."

"Alan . . ." She looked up from her plate. He was astonished to see unshed tears in her eyes. "Honey, I . . . don't want to have a baby right now."

It took him a moment to find his voice. "But—"

I know it means a lot to you, but I just don't think this is the right time. Things are just so . . . uncertain."

"I thought you *wanted* to have a baby."

A pained expression appeared on her face. "Oh, I do, believe me." She stopped for a second. "Alan, I'm scared. Let's just wait a bit longer, OK?"

Dessert was eaten in strained silence.

Late that night after Anne was asleep, Alan crept quietly into the office and called Samuel Watts. "Sam, we've *got* to find them," he said, and hung up, leaving the mystified chief of police sitting on the side of his bed, knuckling sleepy eyes, wondering what that had been about.

Melanie bounced into the kitchen, practically on her tiptoes. Her mother looked up from the table and raised one eyebrow. "What's got you so happy?"

"Oh, nothing," Melanie chirped. She plucked an apple out of the bowl in the center of the table and tossed it into the air. As it fell slowly in the weak Lunar gravity, she positioned herself to catch it in her mouth.

"If you miss, you have to clean it up," her mother threatened.

She didn't miss. She caught it in her teeth and bit deeply before taking it into her hand. "I saw somebody *eat* an apple that way the other day. The whole thing. Every time it came down, they'd take another bite and knock it back up into the air at the same time."

Her mother looked mildly disapproving. "Your father'd say that they didn't have enough to do. Personally, I think it's just a silly way to show off."

Melanie grimaced. "Don't worry about it, Mom. It may be showing off, but it's harmless. It's not like they're playing mumblety-peg in their pressure suits."

"Done with your homework?"

"Sure. Been done."

"You're acting awfully happy. Want to tell me about it?"

"Well, you know when you like someone for a while, but you're not sure whether they like you or not?"

"Joel Ryerson asked you out."

"*What!*" Melanie squawked. "Who told you?" she demanded.

Her mother's mouth twitched. "He's the only boy who makes your eyes glow. It had to be him."

Confused and somewhat crushed that her surprise had been guessed, she asked, "Eyes glow . . . what's that supposed to mean?"

"It means your mother isn't senile, my dear. Get back to the good stuff. What happened?"

"He asked me out." Melanie said,

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now attempting to sound blasé about it.

"When?"

"Tonight. We're going down to level six to that new pizza place."

"Just be sure to be in by eight."

"*What?* Are you out of your mind? *Eight?*" She shook her head in denial. "At least twenty-two, Mom . . . please? It's *Saturday*, for Jove's sake!"

Her mother shrugged. "It's not up to me, Melanie."

The girl darted her head, looking around the smallish tunnel. "Where's Dad? I've got to—"

"It's not up to your father, either. There's a curfew on tonight at eight o'clock."

"A *curfew?* Are you serious?"

"I'm afraid so."

"But we . . . he asked me to go to a party on fourth level after we eat. Mom, I've *got* to go. It's in the Core. Everybody will be there!"

"Melanie, it's not just you, honey, it's everyone. Joel will have to be in by eight, too."

"No!"

"It's not up to me. There's going to be a curfew every night until they catch the men who came up from Earth."

"But, Mom, everybody's worried that they'll do something near the surface. I'll be *deeper* than I am here. The more levels down, the safer I'll be, right?"

Her mother reluctantly nodded. "In so far as it goes, yes. But the fact remains that there's a curfew tonight and everyone has to be in by eight."

"It's not *fair!*" Melanie wailed as she fled from the room.

"I know," her mother [illegible] to the empty air.

Lewis Cantner said, [illegible] to get everyone [illegible] short notice, but I [illegible] added, "And your [illegible] didn't make [illegible]

Alan Lister [illegible] roll his eyes. "Bel[illegible] is as hard on [illegible] else."

"Do you really [illegible] ing to help you [illegible] Cantner demande[illegible]

"Honestly, I don't [illegible] does, because the [illegible] and a bomb loose [illegible] me spitless." He [illegible] Cantner and added [illegible] here long enough [illegible] pressed body, you'd [illegible] concerned. I'm sure."

Cantner was unfazed. [illegible] stringing the busi[illegible] Alan. You're going to cause [illegible] ble damage to our economy."

"With a curfew?"

"Nightclub owners [illegible] hardest, of course, [illegible] late dinner trade too."

"According to the [illegible] percent of the [illegible] tourism comes in [illegible] sector. By and large, [illegible] unaffected by the curfew. [illegible] retail is conducted [illegible] o'clock. The majority of [illegible] eat out are done be[illegible] that great a hardship [illegible] der to schedule [illegible] earlier."

"So you're agai[illegible]

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sitting back and nodding to himself, as though seeing something clearly for the first time.

Lister shook his head. "No, I'm not. My first priority is the safety of the people in this city, whether they live here or not. If you think the curfew is hurting business, I'd like you to consider for a moment what the aftermath of a bombing here in Crisium would entail. Consider what's happened to tourism in countries on Earth that acquired a reputation for terrorist acts. Usually, it depressed business for considerably more than just a few days. Often it was years before everything got back to normal. Look what happened to Paris after they blew the Eiffel Tower. By the end of the week, every hotel in town was running at 10 percent capacity."

"But you don't even know for certain, that these men *have* a bomb!"

"True, but do we want to find out the hard way?"

Samuel Watts looked like a man whose skin was too big. On Earth, he had been a big, beefy career police officer on the Boston metro force. Eight years on Luna had shrunk his muscles, but his skin was no longer as elastic as it had been in his youth, and it seemed to fit loosely.

When the opportunity to lead the Crisium police came up, he had jumped at it, thinking that it would be an easy job. Low crime, no private vehicles to create endless fender-bender paperwork, just sit and wait to retire. Mostly, it was everything he had hoped for.

About two, maybe three times a year he still had to earn his pay, though. The last time had been a hostage situation in a residential tunnel on the second level. Nominally a good neighborhood, but the guy had been under stress at work and had finally snapped. It was about time that something new came up—he just hadn't expected it to threaten the entire city.

The corridors were empty. They echoed. It wasn't that rare a thing, actually. Crisium was still small enough that you could count on most parts of town being pretty quiet after about one or two in the morning. Still, knowing that it was only twenty-two thirty made it seem a little odd.

He was walking, for the simple reason that he could hear better when he walked. The electric carts were a lot quieter than automobiles, but they whined and that annoyed him. Besides, here on Luna, a man needed all the exercise he could get.

The radio tab in his collar squawked and made a hissing noise. Before the dispatcher could speak, he said, "Watts here. What is it, Kim?"

"They've got three men down at the Door. Looks as though they were going to try to sneak back across to Earth."

"I'm on my way," he said, breaking into a long-stepped bounding run for the nearest ramp.

Alan Lister woke instantly when the call came in. He instructed the computer to route the call to the office. As he padded out of the bedroom on bare feet, he was aware of Anne sitting upright in the bed, watching

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him.

"OK, Sam, what is it?" he said as soon as he entered the office.

"We've got 'em."

"The terrorists?"

"They aren't terrorists, Alan. They just ran into the New York terminus to escape the capsaicin."

"That's what we'd been hoping, but what about the bomb threat?"

"Remember that that call took place on Earth. Somebody saw an opportunity to make us worry and took it. These guys were horrified when they heard about it."

"You're sure about that?" Lister demanded.

Watts shrugged. "No way to be certain, but I think they're telling the truth. They're scared to death."

"What can we do about them, Sam?"

The image of Watts shrugged again. "Not much, really. They passed through the Door without paying. That will be up to Lunar Magnetics, as owners and operators of the Door, as to whether they will want to press any charges."

"So there's nothing we can do?"

"Not a lot," Watts admitted.

"We're too vulnerable, Sam. If this had been for real, we'd have had a serious problem. They may have done us a favor by alerting us to a blind spot."

Watts snorted. "Keep that up and you'll talk yourself into thanking them for tying us in knots."

"Still, I want you to develop a plan to handle a situation like this. With things going the way they are on Earth, it's going to get worse before it gets better."

"I'll start first thing in the morning. In the meantime, do you want me to keep these three here?"

"At least until tomorrow."

"Can do. Pity we can't charge them with the bomb threat. That way we could get some satisfaction out of losing sleep over this."

Lister grinned. "Do I detect a subtle jab about waking you the other night?"

"Revenge is sweet," Watts admitted.

Christie Donner knocked at the portal. After a polite wait, she knocked again, louder, hurting her knuckles in the process.

Suddenly the portal flew open, revealing her sister standing in a short hallway. Without thinking, they immediately fell into each others' arms. "Oh God, I'm glad you're here!" Meg Donner exclaimed. "Everybody knows you can't get married without your sister being in the wedding."

"And I haven't even *met* the guy yet," Christie complained.

"I invited you up for Christmas," Meg pointed out, as she relinquished her grip.

"It would have been so much simpler if you had brought him home. Mom's been driving me crazy asking me if I thought you were doing the right thing. How should I know? I'm just a lowly sophomore. You graduated and got a job and a boyfriend . . . now he's going to be a husband. Don't rush too far ahead—I've got to catch up at least a little bit."

Meg nodded inside. "Come on in."

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She eyed the mound of luggage on the corridor floor. "Or perhaps I should tell you to move on in."

Christie grinned. "Since they don't charge for weight going through the Door, I brought as much as I could carry."

"No kidding. You must be stronger than I thought. Here, that much is no problem but I can imagine the sweat it took to lug it around on Earth."

Twenty minutes later they gravitated to the small, round table in the kitchen area. Meg sighed. "I wish Mom could have come."

"It's not could have, it's would have. She's still steamed that you wouldn't have the wedding in Santa Fe."

"It's not would have, it's could have," her sister paraphrased. "Has it not gotten through her thick skull that I can't stand in one full *g* for more than a few minutes at a time? What did she expect me to do? Take my vows sitting in a wheelchair?"

"She doesn't understand, Meg."

"What she doesn't understand is how it feels for my own mother not to want to come to my wedding!"

Christie nodded, then sat silent for a moment. She started to say something, then thought better of it.

"What is it?" her sister asked.

"Mom . . ." She took a deep breath and started over. "Mom says you've changed since you moved up here."

Meg shook her head. "I haven't changed. I—"

"She thinks that you have." Christie shrugged her shoulders. "I do too, but it doesn't bother me as much as it does her."

Meg went very still, a frown deepening on her face. "What's that supposed to mean?"

Christie sighed. "You're starting to sound like all the rest of them."

"Them, who?"

Christie gestured vaguely around her. "Them. The Loonies."

"We're not *Loonies,* we're *Americans.* We're still officially citizens of the United States of America. If it were possible, we'd be another state, but it was agreed a long time ago that no nation could claim territory on Luna as their own."

Christie held up her hands to stop her. "I know, I know. Nobody questions that you're all Americans. The issue is not your citizenship, it's your attitude."

"My attitude? There's nothing wrong with my attitude!"

"There wasn't anything wrong with your attitude until you moved up here."

Meg sat back suddenly in her seat, frustration plain on her face. "You sound like Mom."

Her sister compressed her lips. "You sound like *them.*"

Meg's mouth gaped, then closed. "Just out of curiosity, how do *they* sound?"

"Insufferably proud. Putting on airs. People up here, to us back on Earth, sound as though they're the latest and the greatest."

"That, sister mine, is the exact, literal truth."

Christie had no reply to this, so Meg continued, "To us, Earth comes off as a bunch of whiny, complaining fools who aren't competent to run

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their own lives. Face it. Earth is a mess, and it's getting worse by the day. Here on Luna, we're a fresh start. We're trying to learn from Earth's mistakes."

"I can see that part, but do you have to be so damned uppity about it?"

After thinking a moment, Meg said simply, "Yes, we do."

Alan Lister stepped out of the elevator cage after it settled against the still-uneven floor. He took a deep, sniffing breath and smiled broadly. "I love the smell of a new level."

Tim Smallwood looked at him. "It smells like explosives and greasy chains to me."

Lister shook his head. "No, it's the smell of progress, Tim. I'll admit that it's an acquired taste, but once you get used to it, nothing else comes close."

Smallwood looked around nervously. "The shift foreman was supposed to meet us here."

But Lister was still reminiscing. "You know, this is the third consecutive new level that I've been in. I managed to sneak into a side tunnel they were pushing off of six one time, but a completely new level just *feels* different. It's so *big*."

"It's not that big. Really. This tunnel is only eight meters across by, what, ninety meters long? That's only—"

Lister shook his head and began to walk down the corridor. "You know what your problem is, Tim? You still think as though you were on Earth. Take Emily Starnes, for instance. You totally missed the most important points about her death."

"That she was from Earth?"

"No. The important things were that she was poor and she starved."

"It's sad, but..." He shrugged. "There wasn't anything we could do about it."

"That's what I'm saying. That's an Earth attitude."

"She was already dead when they found her. It's not like we could rush her to a hospital and revive her."

Lister reached out to brush his fingertips over the exposed stone in the corridor wall. "This feels good, Tim. You ought to try it. Everything on the finished levels is covered in smooth, slick plastic or metal. It's a pleasant change to be able to touch something with texture. I had to fight one helluva battle to get the rock left bare in the terminus for the Door." He smiled to himself. "One helluva fight, but worth it."

Relieved to be let off the hook, Smallwood dutifully touched the wall with the fingertips of one hand.

"No, no, no, Tim. Grasp it. *Feel* it."

"I can feel it," Smallwood assured him.

Lister leaned over and picked up a small stone half the size of his fist. He tossed it to his companion, who fumbled and dropped it back to the floor.

"Tim, Crisium is a can-do city. Granted, Emily Starnes was already dead when they found her, but we have done nothing but *react* to the situation. We should have been on top of it from the start. We should have taken a more aggressive stance.

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Now, we're on the defensive and it will be difficult to regain our balance."

"I'm sorry, Alan. I just didn't think it was that important."

Lister turned into a side corridor. "They say she died up here. There's supposed to be . . . ah, there it is." He crossed the width of the corridor and stepped into a room-sized alcove.

"Aren't there . . . bugs or something?"

"Were, past tense. The whole area has been sprayed down with twenty kinds of chemical death. It's sterile again." He turned abruptly and sat on the floor in a rough corner. In a distant voice, he said, "Now, what was different about Emily Starnes? What would make her come here to die? What attracted her to this room?"

Smallwood looked around uneasily. "It's an awful place to die."

Lister shook his head distractedly. "No, it's a good place. When an animal is sick, it goes to a quiet place to lay down and wait for death. It doesn't pick an open spot."

"Emily Starnes wasn't an animal."

"We're all animals, Tim. All of us. There was a psychologist named Maslow who said that you couldn't be a decent human being until your animal needs were taken care of."

"Never heard of him."

Lister wasn't listening. "Turn off the lights out in the corridor, will you?"

"What? It'll be dark as pitch in here if I do that!"

"Exactly."

Smallwood frowned and left in search of the circuit breaker. Lister lay on his side, his head pillowed on his arm. He studied the walls, the floor, the ceiling. Then there was a distant dry snap, and suddenly there was no light in the universe at all.

Jennifer Holmes swore under her breath when her computer announced the incoming call. "Answer the call," she snapped at the computer.

An image materialized to the right of her main screen. A man's face peered at her, then said, "Looks as though I picked a bad time to call."

She looked from the graphics forming as her computer crunched through arrays of numbers to the phone image. "You're . . . um, Edgar Rice. I remember you."

Rice nodded pleasantly. "I interviewed you just after they opened the Holmes Door."

She glanced back at the graphics. "Right," she said, distracted, her attention split.

"Would it be more convenient if I called back later?"

Unable to spare the concentration to answer even a simple question, she muttered, "Uh . . . just a sec."

It was, in fact, nearly three minutes, but Rice waited patiently. In his favor was the fact that Jennifer Holmes was really a very attractive woman. The only thing that kept her from perfection was her right hand. But he was used to that.

At last, she twisted her face and said, "Oh, well. I didn't expect that it would work."

"Didn't expect what to work?"

"I'm working on something I call

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oxbow universes. Right now it's still in the theoretical stage." She snorted. "Actually, I should say that it's in the hypothetical stage. It doesn't seem to be working out very well."

"Did I call at a bad time?" he asked again.

She shook her head. "There is no right time these days. I'll get this whipped eventually, but it's going to be tougher than I thought."

"What if I asked you an easy question?"

"Such as?"

"Your Door. I wanted to get your perspective on Emily Starnes's death."

"That's an *easy* question? I think I'd rather tangle with this." She gestured at the failed graphic. Frowning into the middle distance, she said, "I feel something like the men who created the atom bomb. I'm proud to have created the Door, but sometimes I wonder if there isn't a special ring of hell reserved for me. I have created something that will have consequences far beyond my worst nightmares."

"The Door is not a nightmare."

She inhaled deeply. "That Starnes woman would not have died if the door had not made it cheap to travel between Earth and Luna."

Rice said, "We don't know that. She might have died on Earth."

She continued, "It's like I'm a mother and the Door is my child. And now my child has gone and done something very bad—killed someone, in fact. Now my baby has to go on trial." She faced him. "Is this making any sense?"

He nodded. "Oddly enough, yes. I disagree on one point, though."

"What's that?"

"I happen to know that your child didn't do the killing. At worst, your child was an accomplice."

She shrugged. "Maybe so, but I've sworn off anything that might have practical implications. I'm sticking to cold theory from here on in."

"In our last conversation, you said that you had been surprised that the Door had been... how did you phrase it? Potentiable?"

She smiled. "A hybrid word I made up. It's half-way between potential and possible."

"But at first you thought the Door was just an interesting number game. Then it turned out to be feasible. Now Lunar Magnetics is one of the hottest companies around."

"They hired me when no one on Earth would. I tried to return the favor. I succeeded. End of story."

"You don't work with the Door any more?"

She waved the palm of her right hand in front of her face, as though to dispel a bad odor. There were no fingers on it, only a smooth, rounded pad of flesh. "Nope. The Door is over as far as I'm concerned. I explored all the neat parts, then turned it over to the engineers and technicians. The fun is done, as the expression goes."

"Surely you haven't forgotten it, Jennifer."

She gave him a strained smile. "No, I'll never forget the Door. It won't let me. Or perhaps I should say that people like you won't let me." She paused. "I'm sorry, that came out

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wrong."

"You sound bitter."

She cast a quick glance at the misshapen jumble of colors still forming on her main screen, then slapped at the keyboard with an impatient gesture. The colors vanished, leaving behind only darkness. "Bitter," she said musingly. "Well, maybe I am, in a way. I begin to see what actors complain about when they say that a certain role has typecast them. I think the Door will haunt me in one way or another for the rest of my life. Perhaps it would have been better if it had come along later in my career. As it is, people keep wanting to know what I will do *next*, as though I'm supposed to top the Door, somehow. Yeah, I guess you could say I'm bitter."

"Is it the way that it's being used that bothers you?"

She was silent for so long that Rice began to think that she was not going to respond. "You mean as transportation? No. What bothers me is how *trivial* their reasons for traveling are. Foolish me, I thought that we would use the Door to open up planetary travel. I had visions of bold people marching to the stars. Instead, what we got was a bunch of bored people who come here to shop, of all things. I don't mind that they take the Door for granted, that was inevitable, given time. What bothers me is how quickly the traffic reduced to the lowest common denominator—people who want to buy something here in Crisium so they can flaunt it to their friends the same way they do when they come back from a trip to Europe."

"Was Emily Starnes part of the lowest common denominator?"

Jennifer visibly flinched. "I didn't mean it that way."

"But the shoppers bother you?"

"Commerce was just as inevitable as everybody taking the Door for granted. After all, the Door has to pay for itself, and freight is as good a way as any. Tourism doesn't bother me either. I guess I should say that it's the day shoppers—the people who bounce through for an hour or two to pick up one of those Second Skin suits just to wear to the party that night. About a month ago I saw some figures that indicated that day shoppers made up as much as 35 percent of the traffic on average. Over a third!"

"Lunar Magnetics makes a profit off of those people. That makes them better able to afford your research."

"You make me sound like a hypocrite."

"I'm sorry, I'm not trying to. You did your job and did it well. I gather that you think that you did it too well."

"No," she said, "my problem was that I had idealistic dreams."

"What do you intend to do now?"

She grimaced. "Deal with reality."

Alan Lister stared distractedly at the office ceiling. His wife's visage watched calmly from her office back at the tunnel.

"Anne, this is simpler than it looks. The real issues are being clouded by the emotions. Emily Starnes came here to die. It was subconscious, but

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that was her reason for coming. I'm convinced of that. Her deepest self sought out the quietest, darkest place to die that she could find."

"You're saying that she committed suicide?"

"Not in so many words, no. It was simply her time to go, and she wanted to be left alone while she waited for the end. The busybodies on Earth won't let people die in peace. The medical profession, as a whole, has completely lost sight of that need. They hook patients up to every gizmo at their disposal and keep them around long after they're ready to cash in their chips." He stopped speaking, frowning.

"Honey?"

He waved a hand for silence. A moment later, he shook his head slightly. "Dammit. I lost it. I had one of the threads in my hand, but now it's gone."

"Something about doctors," she supplied helpfully.

"Don't worry about it. It'll come to me." He sighed. "Anyway, all the do-gooders kept trying to save her when all she wanted was to be left alone. So she came up here to die because some part of her realized that we wouldn't be hounding her."

Anne's mouth pursed. "Still sounds like suicide to me. Surely starvation isn't the best way to go about killing yourself."

Eyes still fixed on the ceiling, he replied, "Suicide is the wrong word—it's got the wrong connotations. People who commit suicide are generally regarded as having mental problems, or else they're trying to make a statement."

"You think she had given up on living. Once she reached that stage, she no longer cared much about anything."

He nodded. "Except that she was tired of being messed with. Like when someone persists in talking to you when you're trying to go to sleep. It's an annoyance."

"But why would she give up? I thought the will to survive was one of the most basic drives in human psychology."

He dropped his eyes to meet with hers. "If I can fit the pieces of this puzzle together, I hope to be able to answer that question for you."

Melanie flopped into a seat across the table from her father. "Dad?"

He looked up from his portable terminal. "Hmmm?"

"Can I go out tonight?"

His eyes crinkled. "Your mother told me that Joel finally had the sense to ask you out."

Melanie's face flushed, but she held her ground. "Does that mean yes or no?"

An expression of mock severity came over his face. "Young lady, have you done your homework?"

She rolled her eyes, not accepting his play at humor. "Do I look cratered or something, Dad? Of *course* my homework's done."

Switching to a more pointed tone, he said, "You know Joel is only going to be interested in you as long as you're number two in the class."

"I'm first in physics!" she said heatedly.

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"And he's first in everything else. Keep the heat on."

"*Dad!* Don't run my life for me! Just tell me whether I can go out or not."

He chuckled softly under his breath. "Sure. Just be in by twenty."

"*What?* The curfew's off! It's Friday night, for Jove's sake. I won't even be able to—"

He shook his head good-naturedly. "I was just teasing, honey. How about twenty-three?"

"Oh, midnight, at least, Daddy! Please?" she cried.

"Not just yet, Melanie. Twenty-three," he said firmly.

"But—"

He held up his hand to stop her. "But bring him back here and order in a pizza and you can watch vids or whatever."

"Order a pizza at twenty-three?"

He nodded. "If you're here," he said, tapping the tabletop with a fingertip for emphasis.

She weighed the lack of privacy at home against the alternative, not sure whether she was winning or losing. "Um . . . OK."

"Try not to act too happy about it."

She grinned suddenly. "Thanks, Dad. We'll be here at twenty-three."

"Look at it this way. The first time you went out you had to be in early because of the curfew. Tonight you'll have more time to build up steam."

"What's that supposed to mean?" Melanie demanded indignantly.

He grinned maliciously. "It means that if he kisses you, you'll have the rest of the weekend to recover."

Her face colored immediately. "*Daddy!*"

His eyebrows raised. "Oh, *ho!* So he already has!"

Summoning what dignity she could, his daughter replied archly, "If you must know, *I* kissed *him.*"

He couldn't help it, he broke out laughing. "And to think I could have raised such a hellion on Earth . . . what a waste that would have been!"

Confused, she asked, "What's wrong with Earth, Dad? You always act like they're completely fragged."

He sobered immediately. "I'm sorry. I shouldn't have phrased it that way."

"But you did, though." Then she added accusingly, "You came up from Earth, and Mom, too."

He breathed deeply. "It's not that people on Earth are inherently inferior. There's no genetic problem or anything. It's their society that's at fault. They're complacent—they have no drive, no ambition. And they resent anyone who *is* ambitious."

"But you came from Earth," she repeated.

"That's exactly the point. I took a look around me and decided that things weren't going well, and that there was no indication of things getting better any time soon. So I came up here. People here on Luna have chosen to make something of their lives. I'll admit that there are still a few people on Earth who are moving ahead." He laughed sardonically. "By and large, they're doing so by moving up here."

"Supposedly, the average IQ up here is fifteen points higher than back on Earth. It sounds to me like all that's

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left on Earth are the idiots."

"Don't hate the people who chose to stay behind, Melanie. I get a little frustrated with them, true, but they think they're doing the right thing by conducting their lives the way they are."

"But why would anyone want to live like that?"

"They ask the same thing of us. We gave up grassy fields and trees and sunbathing on the beach in order to come up here. They can't understand that. If they were to put into words what they feel, they would say that their ancestors worked hard and they want to enjoy the fruits of their labors. From my point of view, the fruit looks a little overripe."

"It still sounds as though you're condemning them."

He sat silently for a moment. "I try hard not to, but sometimes it's difficult. They're stagnating and I hate to see that. That doesn't mean that you have to feel that way about them."

"So why did you say I'd be wasted on Earth?"

"If you'd fallen for an average Earth boy, you'd be bored to death with him in a month. Like Joel, you need someone to challenge you. I hope that you'll always be that way."

She started sawing a hand back and forth, playing an imaginary violin. "It's getting a little thick in here, Dad."

He grinned. "Meet some Earth boys. Then you'll understand what I'm saying."

"I don't have to. I've already met Joel."

"Exactly. See to it that you never lower your standards."

Alan Lister was on the line with Lewis Cantner when the priority call signal began to blink in midair, next to the screen. "Excuse me Lewis, I'll have to put you on hold." Without waiting for acknowledgment, he flipped the emergency signal to the foreground by enlarging the blinking red icon.

"Lister," he said tersely.

It was Samuel Watts. "We've got potential trouble brewing at the Door, Alan."

"What kind of trouble?"

"Another protest on the New York end. Bigger than that last one."

Lister nodded slowly. "I see. Are we ready for this?"

Watts's face twitched. "We'll soon see."

"Get everybody out of the terminus who doesn't need to be there. I'll meet you in the control booth at the Door as soon as I can get down there."

Watts nodded. "Right," he said, and broke the connection.

"Anne!"

"Yes?" she replied, her face magically popping into existence.

"Make my apologies to Cantner. I'm on my way to the Door. I want you to stay put. I'm going to need a communications post, and you're it. If something comes up and I'm out of touch, use your best judgment and sign my name to it. I trust you."

"You're keeping me out of the action," she accused. "I could bring a portable terminal down to the Door and run everything just as well from

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the terminus."

"You're quite right on both counts, but, chauvinist that I am, I'd feel as though I had to watch over you, and I don't need the distraction."

She bit her lip. "All right."

"The first thing I want you to do is find Jenny Holmes and get her to the Door, pronto."

She nodded. "Jenny Holmes to the Door," she repeated. "Anything else?"

"Yeah." He slid out from behind the desk. "I love you."

"*I* think everybody's acting crazy," the freight handler said flatly. He was leaning idly against the concrete arch on the New York side of the Door. He was bouncing a rubber ball against the floor on the Lunar side, banking it upwards against the side of a crate and catching it as it flew back into the air on the New York side. The change in gravity caused its trajectory to change each time it crossed the threshold.

Ron Abner, a friend of his who worked on the Crisium side, sat on the edge of the crate, watching the ball. "One thing's for sure. We won't have to do anything for as long as those people are out there. Folks can't get through the picket lines."

"I've never understood what protesters think they can accomplish by yelling slogans. They say they're bringing problems to the world's attention, but if you ask me, I think they just look stupid. Whenever I see someone acting like that, I tune them out. Too much emotion and not enough logic. That kind of attitude scares me."

Abner grinned nervously. "You're not the one they're yelling about. How do you think it feels to be sitting here listening to them calling me a Lunatic? The name doesn't bother me so much as the resentment and hatred that they've talked themselves into. The tone of their voices tells it all." He glanced at the big clock on the wall on the New York side. "They've been out there for almost forty-five minutes, saying the same things over and over again."

"They have one or two points on their side. And you guys have points on your side. It's like a couple who aren't getting along. Little things come up, and if you don't sit down and talk about them they become big things, and suddenly everybody's fighting and saying crap they don't really mean. It's just plain stupid, if you ask me."

"When Emily Starnes died, it's as though everybody on Luna turned into a heartless murderer overnight. We didn't kill the woman, for God's sake," Abner protested.

The other shook his head. "She was just the straw that broke the camel's back. Any other thing that happened at the same time would have caused the same reaction. Like I said, this has been building up for a while. Now we've got to have a big screaming fit and either the couple comes through it or they break up."

"I hope the couple makes it."

"If this were a movie, they would. Movies always have happy endings." He snatched the ball as it sailed over his head. "But real life has a habit of producing unhappy endings."

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Behind them, in the glassed-in control booth overlooking the floor of the Crisium terminus, Alan Lister slid into a seat next to Samuel Watts. "What's the score?"

"Zip—zip. At the moment, the ball is in the visitors' hands. We're reduced to waiting for them to act. Then we react."

Lister frowned. "I don't like that. I never have. I'd rather take the initiative."

Watts nodded, still watching intently through the windows. "I know. If this were war and we intended to deal out mayhem, we could go ahead and start something, but since we're hoping nothing will happen all we can do is be passive and wait."

"What are those people doing out there? I thought I told you I wanted the floor cleared of non-essential personnel."

"They work here."

"How many are essential?" Lister demanded.

"That depends on how you define essential, Alan. If we send the handlers home then we might as well close up shop for the day."

"Still, they're innocent people who could get hurt."

Watts turned and gave him a hard look. "We're all innocent, Alan. None of us killed Emily Starnes, but they've got a fella on the street over there in New York with a portable PA system calling for an investigation. Not just any investigation, mind you, but murder. Premeditated, willful murder. He's got a lot of people who are angry enough to listen to him."

"Murder? Seriously?"

Watts nodded. He gestured toward a button lit blue near his left hand. "That line connects me to the other side's police chief. He says there are about two thousand people out there. If fifty get riled up enough to do something, they could cause us problems." He grinned mirthlessly. "Remember being worried about only three?"

But Lister wasn't listening. "When did it get that bad?"

"When did what get how bad?"

"When did Earth become 'the other side'? You just called New York 'the other side,' as though we're enemies."

Watts blinked. "Just a phrase, Alan. Don't worry about it."

He shook his head. "Has it really gone that far?" He sat for a few more moments, lost in horrified wonder. At last, he shook himself. "I'm going down there and tell the handlers to go home. There's no need for them to be here."

Slowly, he pushed himself out of the chair, then slid open the Plexiglas door that closed the control booth. Immediately, he could hear a subdued murmur from the New York side, but was unable to make out individual words.

Approaching Ron Abner from behind, he placed a hand on his shoulder. "Why don't you take the rest of the day off? There's no work to do here."

"Oh, hi, Mr. Lister." He turned to his companion on the New York side. "This is our commissioner . . . that's kinda like a mayor, but more so."

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Lister stuck out his hand. "Hi."

The baggage handler hastily transferred the ball to his other hand and tore off his leather glove. "I like that."

"Like what?"

"The way you just say hi. You don't sound like you're dredging for votes."

Lister arched one eyebrow. "I don't have to. I'm already in office. I promised everybody that I'm only going to be in office for one term, so I don't have to worry about what they think of me in the next election."

"Our mayor's been in office so long, you'd think he'd grown roots."

"Vote him out."

The handler snorted. "In theory you could do that. In practice, he's there to stay."

Three people filed in the door of the New York terminus and stood quietly, as though waiting. Lister looked them over, then told the handler, "Why don't you go home, too?"

He shrugged. "What? And miss all the fun? Might as well stay. You never know, someone might come in and want a suitcase carried across."

Lister eyed the people standing near the door. There were more now, but he didn't bother counting. Their silent watchfulness bothered him. The Door personnel on the New York side were not really his concern; the Earth terminus handled its own personnel. Still, he felt responsible.

"Hey!"

Lister focussed on the group of protesters standing against the wall.

"Aren't you Lister?"

His eyes narrowed. "Yes, I am," he called across to the one who had spoken. Quietly, he told Abner, "Go on. Get out of here."

Out of the corner of his eye, he saw Abner shake his head slightly. "I think I'd better stay, Mr. Lister."

The protester was approaching, slowly walking across the tiled floor. "What really happened over there, anyway? I mean, why did you folks let Emily die?"

"We didn't know she was here."

The protester, blond, in his late twenties, stopped a few feet away. "A woman comes across, looking the way that Emily did, and nobody notices? Nobody cares?"

"On an average day, almost a thousand people come through the Door. Some are old, some are young. Some are dressed nicely. Some dress more casually." Lister shrugged. "If someone had seen something about Emily Starnes that looked as though she needed help, I'm sure that they would have spoken to her."

"But you were all too busy—is that it? You were all so fired up about being the shining star of humanity that you couldn't spare the time to talk to her."

The freight handler spoke up. "Mr. Lister just told you that a bunch of people come through here every day. What do you expect him to do? Ask each and every one of them if they're doing OK?"

The blond man looked him up and down as though noticing him for the first time. "I wasn't talking to you."

The handler frowned. "What's that got to do with it? Give the man a break, will you?"

"You don't look like one of them. Why are you taking sides with them?"

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"Because they aren't *them*. They are *us*. Just normal guys with jobs to do."

"If they're so normal, why don't they *act* normal?" He turned back to Lister. "Why are you people so cold? Is it that chilly over there that you people freeze up inside? Don't you even *remember* us? We put you there, you know. We paid billions and billions of dollars so you people could have it easy. Now you're so high and mighty that you can't even take the time to take care of one woman. What is *wrong* with you people?" He took a step closer.

The handler laid a hand on the protester's shoulder. "Leave him alone, man!"

The protester spun and planted his fist in the middle of the handler's face. "Stay out of this!"

Without thinking, Lister grabbed the man's arm. He caught one blurred glimpse of the man's face as he snapped his head back around to stare into Lister's eyes. Then the protester crossed over with his other fist and hit Lister.

Dazed, Lister staggered back, vaguely aware of one of the other protesters leaning out into the street shouting that there was a fight. Behind him, he heard the door of the control booth slam open and knew that Watts was coming.

Abner leapt for the blond man, wrapping his arms around him, effectively pinioning his arms to his sides. Not being as strong as the Earth man, that was as much as he could do.

"Somebody get this Loonie faggot off of me before he kisses me!" the protester yelled.

A tall, dark-haired man peeled Abner's arms loose, then kicked him in the groin just as Watts and one of his officers arrived.

Lister glanced up at the control booth to see Jennifer Holmes staring down at him. He turned back just in time to see a third protester pull a gun from under his jacket.

He was tackled from the side just as the gun went off. Landing heavily on his back, he saw the face of the freight handler from New York inches from his own. "Man, you gotta quit trying to debate these guys," the handler grunted.

Aware of a commotion in the New York terminus, Lister craned his neck and looked over the handler's shoulder just in time to see people pouring through the door from the street.

"Close the Door!" Watts bellowed. *"Close the goddamned Door!"*

In the booth, Jenny Holmes panicked. She and Watts had discussed an orderly shutdown of the Door as a possible means of crowd control, but that would take nearly ten minutes. The sight of protesters running across the floor of the New York terminus terrified her. She closed the Door the fastest way she knew—she reached down and switched off the computer that kept the singularity aligned with the terminus on Earth.

There was a sound like that of ripping paper magnified beyond the tolerance of human hearing. Lister's view of New York grew foggy as a sudden drop in air pressure condensed the moisture in the atmosphere. Through the haze, he watched the Door constrict into a fuzzy circle

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the size of a basketball. He had the distinct impression that New York City was receding from him at tremendous velocity. Then the circle closed, leaving only a blank cold stone wall.

It was then that he saw the man with the gun fall forward onto the floor of the Crisium terminus, screaming thinly, half of his body gone.

Jennifer Holmes sat on the side of the examination table in the Crisium hospital, staring blindly at the floor. Her face was pale and drawn.

"Here," Samuel Watts said quietly, handing her a small green plastic cup of water.

Her hands remained where they were; she gave no sign of having heard him. "I didn't mean to do it."

"I know," he said, reaching out to lay a gentle hand on her shoulder.

"It was awful. I've never seen anyone die."

Watts turned and sat next to her on the cot. He was not surprised to find that she was shivering. He draped a light blanket over her shoulders. "It was my fault, Miss Holmes. I told you to close the Door. You were just doing what I told you to do."

"He screamed," she whispered.

Alan Lister appeared at the portal. Watts looked up, saw him, and shook his head slowly. Gently, he disengaged and stood. They went a discrete distance down the corridor before speaking.

"They want Jenny," Lister said flatly.

"Who? Earth? For what?"

"Manslaughter."

Watts narrowed his eyes. His face took on the look of a granite slab. "They can't have her."

Lister turned away and looked back towards the room where she sat. "How is she?"

"She was watching the Door when it closed. She saw the whole thing." His mouth tightened. "She's not taking it well."

"I don't blame her. It wasn't like anything I've ever seen... or ever want to see again." His gaze was distant.

"Tell them they can have me, instead."

"What?" Lister asked, focusing on Watts once more.

"Earth. Tell them it was my fault. Tell them I'm the one they want. The whole plan was my idea. You told me to draw up a defense plan and I did it. I just never thought that we'd kill someone closing the Door."

Lister shook his head slowly. "As far as I'm concerned, they can't have either of you. I'm going to handle this a different way."

Unnoticed by most people, economic cycles come and go. Longer term waves, called Kondratieff cycles, recur roughly every fifty-two years. Shorter term rhythms, such as the Juglar and Kitchin cycles, ebb and flow on the Kondratieff cycle like individual waves on the tide.

The tide was about to turn.

The North American economy was already on borrowed time. Monetary policy, mounting political tensions between Brazil and Argentina, con-

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sumer spending patterns, and a host of other factors had conspired to place the economy in a position of extreme delicacy. One false step and the entire house of cards would come tumbling down.

Any economist would have said that it was an elementary observation that the thriving Lunar colonies were a critical element in the North American economy. The voracious Lunar demand for durable goods was desperately needed, since the faltering economy on Earth could no longer sustain a full industrial production schedule by itself.

Within hours of the forced closing of the Holmes Door, the New York Stock Exchange crashed, losing over 900 points by the end of the day as traders realized the implications of the loss of demand.

Although the country as a whole does not depend on the stock market, it is widely followed as an indicator of the health of the economy. It did not take the employee layoffs that began within two weeks to make it obvious that a major economic downturn had begun.

As unemployment soared, people were forced to worry about more immediate concerns, such as meeting their own bills. Perceived problems with the Lunar colony in Crisium began to take a back seat to the local economy. The seeds of an isolationist policy were sown.

Studies were commissioned. Fingers were pointed. The obvious solutions were suggested, primary among them that Crisium be forced to reopen the Holmes Door and resume trade with North America.

Those in Crisium, however, watched the news broadcasts that showed the riots. They listened to the politicians and the man in the street blame those on Luna for their woes. They heard the extremists who called all Lunarians murderers.

Knowing how fragile his city was and that it would only take one terrorist act to kill hundreds of innocent people, Commissioner Alan Lister prevailed on Lunar Magnetics to keep the Holmes Door closed. Having had two crises, he was not anxious to test the axiom that the third time pays for all.

"This is the part I've never figured out," Hammond Kent said. "What do you do after the ribbon cutting ceremonies are over?"

Alan Lister, tired, worn, and depressed, turned his head and looked at him. He shrugged as he leaned against the railing on the observation deck overlooking the new Holmes Door in New London. He and Commissioner Kent had just officially opened a Door between Crisium and New London. In five weeks another Door would connect Besselton to Crisium. Thus, all three of the major cities on Luna would be interconnected, creating a unified Lunar population. "I honestly don't know. I don't feel like going back to the office."

Kent frowned slightly as he studied the gaunt man before him. "You ought to take a break, Alan. God knows you've earned the right. You've done the impossible, getting

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this pulled together in this short a time."

He answered indirectly. "Lewis Cantner and his Crisium Business Group are after my hide. They'll be glad to get traffic from New London, Besselton, and some of the smaller outlying communities, but it won't be what they were accustomed to seeing coming through from New York."

Kent nodded and said, "True, but keep in mind that with a major depression beginning down there, there would have been a sharp drop-off in traffic, anyway. Hell, if you hadn't fought tooth and nail to keep the Door closed, we would have been sucked down, too."

"It was a gamble."

"It was a successful gamble," Kent corrected. "You isolated our economy from Earth's. Did you know they're having food riots already?"

"I haven't had time to keep up with dirtside news," Lister said quietly.

"Unemployment is at 15 percent. By the end of the year they're projecting 19. Business failures are exceeding all historical rates. Banks are collapsing right and left as people try to get their money out." He grunted. "And to think it all started with Emily Starnes. One woman. That's the part I find hard to grasp."

Lister inhaled slowly, then said, "That's the one part I *do* understand."

Kent pushed back from the railing, his attention riveted. "You mean you know what happened?"

"It's so simple and so obvious that we completely missed it." He straightened and faced Kent. "It's evolution, Hammond. Pure and simple."

"Us being the best and brightest of humanity? That's old news."

"No, it goes deeper than that. Much deeper. It explains Emily Starnes, as well." He stared off into space, distracted, remembering. "One day I was talking to Anne and I almost got it. I was this close," he held up fingers barely spread, "but it slipped away."

"So what was the key?"

"Doctors."

"What?"

"Oh, not that they're the root of the problem. It was just the end of the string that I used to unravel the knot. Once you see the form of the problem you can come at it from any number of angles. For me it just happened to be doctors."

"So what have doctors got to do with the economy?"

"They won't let you die."

Kent frowned. "Either you've slipped a cog or I have. Which is it?"

Lister's mouth twitched as though he was trying to smile. "Neither. Think of it this way—for millennia, people died."

"Now *that's* profound," Kent observed.

Undeterred, Lister continued, "But look at *how* they died. They died from diseases. They died from wounds that they got from accidents, or in battle, or from wild animals. In one way or another, those deaths improved us."

Kent nodded. "Basic evolution."

"Right. There's just one thing that everyone forgot—evolution is still with us today. Our egos want to believe that we are the pinnacle of evo-

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lution. 'Tain't so."

"So far, I don't see the blinding insight, Alan. It sounds as though you're just going to say that we picked the best Earth had to offer, and that Luna represents some new stage in evolution."

"That's true, but it's a trivial observation. There are other, more subtle selection mechanisms at work here."

"I guess I still don't see what you're getting at."

"Every time we conquer another disease, we brag about increased life expectancies. Everyone applauds. But there's a price—our gene pool no longer selects for resistance to disease. Every time some fool got careless with machinery and was killed, they made the machine safer to use . . . and our gene pool quit weeding out stupidity."

Kent started to say something, but fell silent.

"We have removed too many of the harmful things from our environment. Life has become too safe. But Darwin is still out there, waiting. One way or another, evolution keeps right on ticking." He smiled faintly. "Economics, Hammond. Evolution is now using fiscal fitness as the selection criterion. Nowhere is that going to be more evident than on Earth over the next few years. Those who had the foresight to prepare for this depression will be better able to weather the storm. They will have laid aside money to buy food. They will be the ones who are able to buy tools to work their gardens. They will be the ones who will be able to afford cows for milk and meat. When the economy eventually turns up, they'll be the ones who hit the ground running."

"And Emily Starnes? Where did she fit in?"

"Emily Starnes was a marginal case. In kinder, less stressful times she might have made it through. I heard that her husband was a driven man. It takes that to get ahead. There are no easy pickings these days. In a more benign economic environment, he might have been able to succeed with less effort. But as it was, he had to hustle. I don't know the details of what happened between them, but I'll wager that she thought he wasn't paying enough attention to her. She couldn't cope with the realities of the situation." Lister held out his hands, palms up, as though weighing alternatives. "It sounds cold, but that's the way it is."

"So you're saying that *all* the homeless people are economically unfit? I can't accept that. There are too many who are simply victims of fate."

"Hammond, think of it, not as economics, but as a tiger. If a native leaves a village to walk to a neighboring village, he is continually making choices. Perhaps there is more than one way to get there, so he chooses a particular path. Once on that path, he knows he should be on the lookout for tigers, but does he actually do so? When he sees a tiger does he panic and run—something sure to attract the tiger's attention? Does he pick up a stick and try to fend off the tiger, or does he cower and wait to be eaten? Perhaps it was fate. But maybe, just maybe, if he had been just a little more alert, he would

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have been watching more carefully for spoor."

Kent shook his head. "I still can't see how a man who starts a business can be blamed for going bankrupt if the economy drops out from under him."

Lister said, "A man who starts a business without taking into account the larger economic picture is a fool, Hammond. The same is true of a man who applies for a job in an industry that's highly cyclical. He may get the job, but as soon as the company goes bankrupt, he's back on the street. It's like building a sand castle at low tide; you can be the best sand castle builder that ever lived, but you're doomed to failure."

"Those who built their castles well—perhaps out of stone instead of sand—will be able to withstand the waves. Is that it?"

"Don't stretch the analogy too far. Keep in mind that you could conceivably build a poor structure, but build it above the tide line, and still survive. There's more than one way to get through hard times."

"I think I'm beginning to see what you're getting at."

"I don't know whether isolating us from Earth will work. Clearly, we're in for a rough ride as we wean ourselves from all that money that was coming up through the Door. The Crisium Business Group has been giving me hell each and every day, telling me how hard I've made it on them. My hope is that, since the Door wasn't open for that long, not even a year, that they haven't forgotten how to run a lean business." He chuckled. "Perhaps they *have* forgotten . . . if so, Darwin may be their next, and last, customer."

"Maybe the larger population base our three cities provide will help them all stay in business."

Lister shrugged. "I'll be content if we only suffer a recession instead of a depression. Anne has a better head for figures than I do. She ran all this out on one of her computers. She projects that we'll stabilize within nine months, then begin to grow again, albeit slowly at first." He shook his head sadly. "Earth won't even hit bottom for another year or two after that. There's no telling how long it will be before they have a healthy economy again."

"I hope you're right."

"Like I said, it's a gamble. It's too soon to tell for sure whether it will work out."

Kent said, "I have a feeling that it will."

Lister gave him a tired grin. "If this doesn't work, we'll try something else. We're adaptable. Evolution got us where we are today, and if we stay on our toes, we'll still be here tomorrow." ■

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THE REFERENCE LIBRARY Tom Easton

Rainbow Man, M. J. Engh, TOR, $17.95, 251 pp. (ISBN:0-312-85468-4).
Burning Bright, Melissa Scott, TOR, $21.95, 345 pp. (ISBN:0-312-85502-8).
Dream of Glass, Jean Mark Gawron, Harcourt Brace Jovanovich, $21.95, 367 pp. (ISBN:0-15-126569-0).
Ecstasia, Francesca Lia Block, ROC, $8, 183 pp. (ISBN:0-451-45260-7).
Dragon Rigger, Jeffrey A. Carver, TOR, $23.95, 480 pp. (ISBN:0-312-85061-1).
Nebula Awards 27, James Morrow, ed., Harcourt Brace & Company, $24.95 hb, $12.95 pb, 229 + xviii pp. (*ISBN:0-15-164935-9 hb, 0-15-665471-7 pb*).
Challenges, Ben Bova, TOR, $21.95, 350 pp. (ISBN:0-312-85550-8).
Accursed Wives, Bruce Boston, Night Visions (Ree Young, Rt. 2, Box 357, Troy, NC 27371), $3.50, 24 pp. (ISBN: none).

M. J. Engh made a considerable splash with her first novel, *Arslan,* for two reasons: first, it was built upon some quite outrageous proposals for how to save the world, and second, Engh was clearly a very good writer. Her second, *Wheel of the Winds,* was quite good, but it did not seem to me as remarkable a performance, at least partly because she had already been about as outrageous as one can be. That is, *Arslan* was hard to top; after that, anything Engh did had to seem more ordinary, even if it were good enough to turn any other writer into a star.

Sadly, this remains true now that Engh's third novel, **Rainbow Man,** is here. It's a well-told, interesting, thought-provoking tale with sympathetic characters. It even has an outrageous central idea that echoes *Arslan*'s claims for the social value of torture. But that central idea is telegraphed to the reader so early in the tale that the protagonist's persisting ignorance makes her seem quite stupid.

That protagonist is Liss. She dwells on a slower-than-light starship that takes years and generations for its journeys. Her home is a world of its own, but there is a sense of separation from the bulk of humanity that drives some starshippers to leave their ships when they find what seems a congen-

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ial world. Liss is one of these discontented individuals. The world she finds is Bimran, where there are no laws and people are very nice people. There are regulations, however, and an immigration officer who tells her that because she has been surgically sterilized, she is an "infertile adult human," or—by Bimran definition—a man. As an ominous note, on the very day of her arrival she sees someone being dragged off screaming.

So Bimran is just a little quirky. In fact, that bit about defining Liss as a man invites us to call the place a loony bin. Yet Engh seems to be saying it all makes sense, it's not really nuts, it's a nice place, it's got lots of nice folks. We scratch our heads until Engh reveals that this is a very religious world whose people do not believe in heaven and hell after death. That would be illogical and ungodly, for it would serve no purpose. Yet suffering obviously is something god approves—after all, it certainly exists—and surely god must approve even more if it is made somewhat less haphazard. Hence the Selectors, who watch the Bimran population like so many black-clad hawks for signs of unusual virtue or vice. Occasionally they choose someone, and he or she is taken away to a long lifetime of either bliss or agony.

It's really no wonder the Bimranites are so nice. Nor that some would dearly love to leave the planet, if only those who passed for authorities would let them.

Liss makes friends, two of them men with whom she could easily have a sexual relationship (one of them a Selector) if she were not a "man," sex outside marriage were not sinful fornication, and same-sex were not damnable perversion. She is thus a disruptive influence, a source of temptation, ripe for Selection herself—if she were not an immigrant starshipper. Selection, you see, is only for natives—until the authorities decide to change the definitions and Liss is suddenly in jeopardy.

The romantic entanglements that help to drive the plot while Liss is learning about the horrors that lurk in the Bimran background never do get resolved. They cannot within the Bimran context, and it is much to Engh's credit that she does not violate the context she takes such pains to establish. I only wish such authorial integrity could be enough to make the story more satisfying. Unfortunately for satisfaction, what resolution the tale has depends too heavily on Liss's final jeopardy and her efforts to escape Bimran and survive—and all this happens in the last fifth of the book. That is, it takes Engh far too long to introduce any great degree of dramatic tension into her tale, and then she releases that tension too quickly and easily, thus undercutting what she has been telling us all along about what a pickle her protagonist is in.

Melissa Scott's last novel, *Dreamships,* drew considerable praise. Her latest, **Burning Bright,** will draw even more, for the characters, setting, and intrigue are more convincing and the pacing is better. If you like fiction informed by the spirit of Machiavelli,

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you'll love this one. You'll also love it if you like stories that reflect a bit upon the art of which they are a part.

Burning Bright is both a world of wide seas and a city of canals ruled by merchant princes that remind inexorably of Venetian doges. To this futuristic Venice, on the eve of its annual season of stupendous Storm, comes Quinn Lioe, a full-time pilot and a part-time Gamer who has been gaining renown for the quality of the scenarios she constructs for others to play in the computer-aided role-playing Game of intrigue and war that has spread across human civilization. This Game is a consensus structure that goes on and on; no one dares to write the scenario that will wrap it up for then it must end and a new Game be devised.

It is tempting to compare Scott's Game with modern science fiction and fantasy, a literary genre with a very strong consensus component and an immense resistance to fundamental change. Certainly Lioe is comparable to an up-and-comer such as Scott herself, earning high praise for the work she does within the consensual frame but aching to break free. The novel itself is comparable to Lioe's scenario, excellent work within the frame. Scott/Lioe's wish to break free suggests that if only the consensus could be shattered, we might see some astonishingly fresh creations that would reawaken that old sense of wonder.

To return to the story: Upon arrival, Lioe visits a Gaming club and sets up to run her latest scenario. At the same time, the human ambassador for an alien civilization of quite Byzantine political philosophy (the hsai) is worrying about a hsai visitor who opposes his own masters' party. A local merchant is plotting with that visitor a smuggling deal that he expects to give him status among the hsai and ascendancy on Burning Bright (the package to be smuggled actually arrived on Lioe's ship) and worrying that ex-master Gamer and skilled explorer of the computer net, Ransome, will detect and queer the deal—unless he is somehow sidetracked. The best way to sidetrack him would be to get him back into the Game.

As it happens, Lioe's Game scenario is of sufficient interest to attract Ransome even without the doge's scheming. She learns what Ransome does instead of Gaming—not commerce, but art—and she begins to think of crafting that ultimate scenario that would resolve the Game and make essential some fresh, new replacement. Yet the time for such action is not ripe. First Ransome must realize that the doge has been trying to manipulate him, wonder why, and find exactly what the doge wished he never would. The ambassador must stand revealed as an old friend and lover of Ransome, the hsai visitor as a foe. The storm must approach fear and paranoia crest as the seas invade the canals. There must be kidnapping, desperation, death.

And finally the storm must ebb, leaving strange new things washed up on the shore. Perhaps they will climb to their wobbly legs and walk. Perhaps not, but the onlooker feels both

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satisfaction and promise at the prospect.

Certainly Scott, like Lioe, is a personage within the Game she helps create. I can't help but wonder what she would create if she, as her character seems to do, could escape that Game.

Jean Mark Gawron is a computational linguist who works in the field of artificial intelligence. That is, he is on intimate terms with one of the topics with which science fiction has been concerned for many years, and it is no surprise to see him displaying that intimacy in the form of a science fiction novel, **Dream of Glass.** Unfortunately, even though the novel has a great many intriguing takes on AI, Gawron fails to convince because he anthropomorphizes all his AIs until the end, when he finally reveals his Galactics. Even more unfortunately, Gawron's characters tend to be quite thinly sketched stereotypes, especially the political schemers responsible for the situations that drive the plot.

The novel's setting is the America of the PostPublic, an information-economy whose ideology is based on a pseudoreligious philosophy that regards each individual's individuality as something like a unique godhead. Those who lose their memories may become new individuals. Those who either defy the system or are not part of it—farmers and craftspeople, for instance—are oppressed as brutally as by any autocracy.

Meet Alexa Augustine, a country child with an immense native talent for interfacing with the PostPublic's computer systems. She lives with her grandmother until a Galactic ship, with its cargo of priceless information, lands nearby. The soldiers come, execute grandma, and take the child away for training. Later she is damaged in a local war, reconstructed as Augustine, a new person for whom Alexa is no more than "causal antecedent" and the source of numerous fragments of memory. Augustine is also skilled at interfacing or "doing glass," and it turns out that the authorities have plans for her: she is intended to be their key to full access to the information treasures of the Galactics. Yet her reconstruction is partly in the hands of an AI with its own agenda. There is Cowboy Bob, a hacker with a dedication to the idea of free access of the masses to all information. There are the high priests of the system, who seem to have quite an inordinate interest in this one rather pathetically bewildered woman, an interest that grows more and more intense as she gains her interfacing powers and displays the ability to access Galactic secrets. And finally. . . .

I shouldn't say too much, should I? Let me leave you, then, with questions: Does Augustine ever get in touch with her past? Who are the Galactics, and what do they want with Earth? What does the AI Quincunx really want, and will Augustine survive it? Will the PostPublic itself survive?

Will you enjoy the book? Gawron's style is not as lean as many of you may prefer. At times his transitions

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feel abrupt and arbitrary. If such things are not enough to turn you off a book, the answer is, "Yes."

If you like intensely explicit allegories, you'll love Francesca Lia Block's **Ecstasia.** She has constructed a Hollywood tinsel city stand-in, Elysia, in which all the emphasis is on fun, entertainment, and youth. When your wrinkles show, you go underground to Under, a land of despair and death. The only other choice is Desert, the hinterland beyond the city's bounds, where people must work and grow old and die.

One day, a strange man, a dealer in healing potions, comes to a Desert community. When he leaves, he takes with him Estrella, a lovely girl who craves the delights of Elysia. They have two children, Rafe and Calliope. Estrella sees the signs of age and dives underground. He disappears.

Years later, Calliope and Rafe are part of the musical group Ecstasia with Dionisio and Paul. Calliope goes Under in search of their parents. Rafe follows to bring her back and while Under sees Lily, the acrobat he loves; later he learns that Lily goes Under to obtain a drug, Orpheus, that will bring her lost parents back to life in her mind. Lily dies. Rafe himself seeks the drug and discovers its dispenser, Doctor, and his three dissipated hangers-on, Chloe, Shana, and Leila (later Block identifies these women as maenads, devotees of Dionysus, but there are also hints that they are Furies and might well be named Megaera, Tisiphone, and Alecto). When he falls under the drug's sway, Calliope, Dionisio, and Paul struggle to save him. Yet his doom lies in the very nature of Elysia. He must abandon hedonism, flee to Desert, and there wait for his sister and partners to join him, if they can. Then, perhaps, their music will make the desert bloom.

It is not at all unusual to find modern fiction showing parallels with ancient myth. After all, it is an easy way for a writer to make a story resonate in minds that have heard the myths before. Yet what Block is doing is not that simple: the resonances are there, but there are also dissonances, some because she mingles myths such as that of Demeter and Persephone with that of Orpheus and Eurydice, some because she gives mythic roles to inanimate objects such as drugs. The result is intriguing, enchanting, clearly ambitious. If it fails, it fails because Block sometimes seems to strain too hard to intrigue and enchant and achieves little more than preciousness.

A little while ago, Jeffrey A. Carver called to say that he had just finished **Dragon Rigger,** the sequel to *Dragons in the Stars;* TOR would be bringing it out in June 1993 as a hardcover, and was I interested in seeing the manuscript? "Of course," I said, for waiting for galleys—the usual course of events—would mean getting the review to you potential book-buyers far too late to be useful. In fact, since TOR was scheduling publication so promptly, there really wasn't any way to get the review out at the same time as the book, but working from manuscript

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would at least improve the situation.

So he didn't send me the manuscript. He sent me disks, which has its awkward side but saves postage and means that if his house burns down before I'm done he hasn't lost the whole durned thing.

And I can now tell you that *Dragon Rigger* is a sequel that is actually better than its predecessor. It is a most excellent adventure that would make a grand movie if it were not that the special effects budget would surely be quite brutal even in this age of computer animation.

In the earlier volume, we met Jael, a star-rigger who pilots spaceships through the Flux, a subspace that responds to mental imagery and intent. Flying into a region of the Flux rumored to hold dragons, she discovered the rumors to be true, found the dragons threatened by supernal evil, and after conquering her own internal demons, aided the dragons in their battle for survival.

As *Dragon Rigger* opens, we learn that other riggers have also returned from the Realm of dragons. One is the drunken Kan-Kon, at whose stories all the other drunks howl with laughter. Jael overhears him, inquires, and makes a friendly overture which will pay off much later. Meanwhile, the evil she helped defeat before is ascendant once more. Tar-Skel, the Nail of Strength, is building a web of sorcery that threatens to engulf not only the dragons' Realm but also every other region of the Flux and even the "static" universe in which Jael dwells. Dream Mountain, the home of the dragon females, the only place where dragon eggs can hatch, the fount of all the energies that maintain the Realm, is missing. The only hope is the memory of a heroic Jael who seems to fit a prophecy of "the One" who might save the Realm. Yet she is gone, and there is no way to call her, unless. . . .

The ifflings may have a way. Using the last of the reproductive energies they can muster without regaining Dream Mountain, they craft a mere handful of offspring and send them into the static universe. Despite Tar-Skel's sorcerous counter, the message gets through. Jael, her partner Ar, and her cybernetic parrot find that drunks can be surprising people and reach the Realm. Unfortunately, Jael promptly becomes a captive of the foe, who plans her death to give his malicious web all the power it needs to . . .

If there is a motto for this novel, it is *solidarnosc*, solidarity, the power to be gained by sticking by one's friends, even by sacrificing for the good of others. The basic structure of the story is comfortably familiar —perhaps too familiar—and the dialogue is often stilted. But there is immense verve, energy, momentum, and power. Even though the outcome is never in any doubt—at least in outline—the reader stays with Carver all the way.

Perhaps it helps that for so much of the story the characters are dragons rather than humans, which makes the essentially standard plot ring rather fresher.

It also helps that Carver has devised a way to make purist fantasy—dragons and sorcery, for-

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sooth!—fit within an SF frame. The Flux is subspace, the medium of ftl travel, but it is distinctively a realm of imagination. In it, almost anything goes—and we should note that Carver mentions that there are other Realms within the Flux. Perhaps he is warning us that he is going to fit other fantasies into the same frame.

Once more, James Morrow has assembled an anthology of memorable fiction. It is **Nebula Awards 27,** and it salutes the best SF writers of the year 1991. Here you will find not only Nebula Award-winning short stories such as Alan Brennet's "Ma Qui," but also the finalists—Terry Bisson's "They're Made Out of Meat," Karen Joy Fowler's "The Dark," John Kessel's "Buffalo," and W. Gregory Stewart's "the button, and what you know." For novelettes, there are Mike Conner's winning "Guide Dog," James Patrick Kelly's "Standing in Line with Mister Jimmy," and Susan Shwartz's "Getting Real." Nancy Kress's winning novella, "Beggars in Spain," is here, as are excerpts from Michael Swanwick's winning novel, *Stations of the Tide.*

I feel little need to say much about the stories, since I have mentioned many of them before. Suffice it to utter a round of applause for an excellent selection and to add that if you wish to introduce a friend to modern SF, this book and its predecessors would serve the purpose very well.

What else is here? You will find a thoughtful, perceptive review of the year in SF by Kathryn Cramer, in which she notes that SF seems to be splitting into two camps that might be dubbed "SF for SF's sake" and "SF for any other sake." Bruce Sterling describes his encounter with litcrit to amusing effect. Bill Warren reviews the year's films. Joe Haldeman and David Memmott present their Rhysling-winning poems. And Arthur C. Clarke, George Zebrowski, and Harlan Ellison bid farewell to Isaac Asimov; to this, Asimov adds a farewell of his own.

An excellent addition to any library shelf.

In the foreword to his latest collection of stories, **Challenges,** Ben Bova says that each story is—or should be—a challenge to its writer. As he introduces the individual stories, from "Answer, Please Answer," a 1962 comment on just how desperate the need for contact with alien intelligences can be, to "Thy Kingdom Come," the best tale in the book, first published here, he says a little about the kinds of challenges they posed him. He then offers half a dozen nonfiction pieces on the future, science, science fiction, and writing. The attention Bova pays here to writing and its problems means that the book holds a modicum of instruction for other writers, both wannabees and pros.

Yet it holds more widely applicable lessons as well. The essay "2042: A Cautiously Pessimistic

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View," was commissioned for *The World & I,* a Unification Church ("Moony") publication. In the guise of a speech by a future World Council leader, C. C. Lee, it reminds its readers that refusal to restrain greed for resources and children promises disaster. Whether you think Moonies are crackpots or not, this is a salutary lesson, and if you don't like it in speech form, Bova used the same ideas as the basis for "Thy Kingdom Come." In this tale, a crumbling Philadelphia is about to be visited by that same C. C. Lee. Local thugs, aided by foreign agents, plan to kidnap him and demand as ransom the overthrow of a dictator. But Lee refuses to negotiate; the fate of the world is more important than the fate of any single politician or statesman. And slum resident and electronics whiz Vic Passalacqua, desperate to rescue the girl he loves from both cops and thugs, order and greedy viciousness, is caught in the middle. This one could win an award or two.

Bruce Boston's **Accursed Wives** is a small collection of gimmick poems, each one constructed in answer to the classic sfnal question, "What if . . .?"

"What if what?" you say? Well, what if you're a woman and you're married to a shapeshifter, a werewolf, an alien, a sasquatch, a devil, a brujo, a monster, a ghost, a demon, an angel, a telepath, or a mad scientist? Would your life be all roses and chocolate hearts (I'm writing this just before Valentine's Day)? Or would it have its negative side? That is, might there be a way to see each of these hubbies as a curse of a different sort?

Some of Boston's answers are better than others. I thought the "Curse of the Shapeshifter's Wife" rather cute (as well as salacious), and the "Curse of the Werewolf's Wife" cogent. The "Curse of the Devil's Wife" had a nice bit in "on weekends they stay home and watch the paint blister." Some of the rest did not appeal or struck me as weak for any of several reasons.

Overall, Boston maintains his status as one of SF's premier poets on the basis of other work. ■

You may be disappointed if you fail, but you're doomed if you don't try.

Beverly Sills

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BRASS TACKS

Dear Stan,

Some thoughts on the February 1992 editorial, "The Manuscript That Never Was." Mr. Levin bemoans the vanishing of original manuscripts for historic reasons and the value of having the original documents. You conclude that collectors and historians will become an endangered species unless an innovative solution that serves both the authors and historians is discovered that preserves document development histories.

Screen editors were available to programmers and on large publication computers before word processing escaped into the normal world. A solution for the historian may already be out there. Something that preserves your previous versions in case you want to refer back to them. It just hasn't escaped out of the world of programmers into word processing. Yet. (At least I haven't seen it.)

As a programmer working on large programs and their documentation for years on end, I find having an archival list of previous changes more than nice. It can save hours, days, even weeks, of debugging. In the bad old days I kept reams of paper around my office printing every major release of the different programs. Changes were handwritten on them until the next printout was made. In the editorial you admitted to some desire to keep your previous changes just in case.

Like yourself, I have some sympathy for collectors but am not bothered by original manuscripts being replaced by floppyscripts. I am greatly bothered by the lack of a revision history in word processors for large or complex documents. I have been spoiled by "archiver" programs, such as **sccs** of UNIX™[1].

Archivers track revisions made to a file at key times. Programmers versed in reading **sccs "s."** archival files can quickly review changes made to the file, including who made the change, what was changed, when the changes were made, and hopefully a note on why the changes were made. A command to the computer can call up any of the previous copies for review or enter a new revision into the archives.

I would love to have a word processor with a built-in archiver. Using an archiver takes *much* less disk space than simply keeping separate

[1]Sorry, but "source archivers" of the programmer world only use Ascii files and thus do not work well with most word processors.

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copies of each update as everything is in one file. Only the differences are saved. Archivers built into word processing programs should be *much* easier to use than **sccs** and keep us from tripping over piles of paper. I think most of us already keep our latest copies on floppy disks, for backup if nothing else.

Another trick is to include "comments" in your document: text that appears on the screen, but not in the printed document. You can keep all sorts of useful information within comments.

While archivers and comments may not solve Levin's "original document" problem it would solve the history problem. I predict that archivists, literary scholars, teachers, and yes, even authors, would find archivers useful.

As far as manuscript values go, floppy disks with hand-written labels are all collectors are likely to get in the future. Such floppyscripts would not be met with the joy of hand-written originals, but it would be better than nothing. As you pointed out, original manuscripts are now an endangered species. ("I have here Stanley Schmidt's working floppy, written on his very own PC.")

GILBERT HEALTON

Los Angeles, CA

Dear Mr. Schmidt:

I have been a reader of *Analog* for many years and am surprised to find myself writing this letter in reference to your editorial in the February '93 issue.

I am a computer consultant and one of my clients had a need for tracking changes in documents. We were able to resolve the problem with an off-the-shelf word processor which keeps track of changes to any document. Unfortunately this word processor is, as far as I know, only available from Unisys running under their CTOS operating system (It is called OFIS Document Designer). I am sure though, that as the need arises similar word processors will be made available on DOS and other operating systems.

Although I realize that this is probably not the ideal solution for collectors or writers, it is a beginning.

BORIS KORTIAK

Levittown, PA

Dear Stan,

In your description of Barry R. Levin's unhappiness about the probable fate of manuscript collecting (editorial, Feb. '93), I recognize symptoms of a mind-set possessed by those who collect things solely for the purpose of acquiring the unique or uncommon. These people seem to think that whatever they prize is only produced so they can collect it, and that the producers and users should give the interests of collectors higher priorities than their own.

Two examples from model railroading demonstrate this delusion in its most virulent form:

1) A modeler wanted a precise model of a specific (by railroad, road number and date) steam locomotive. Since none was available, he purchased the (hand-made in Japan) brass model which most closely re-

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sembled it, then changed the location and details of pipes, pumps and so forth to provide what he desired. When his account of the modifications reached print a "brass locomotive collector" took him to task for "spoiling" the original brass model, which the collector wanted and had been unable to obtain (!)

2) The first brass models of Union Pacific's 4000 class "Big Boy" were cosmetically beautiful mechanical junk. In a series of *Model Railroader* articles a gentleman named Darwin described what he had done to make a Swiss watch out of a sow's ear. Once again a "collector" surfaced to bemoan the loss of an original Tenshodo, one of only fifty made, and to vilify the person who had done the dastardly deed of improving it. (I guess the others all went to people who wanted to put them in glass cases rather than at the head ends of long model freights.) The personal attack discouraged Mr. Darwin from completing the remainder of a series of planned articles, which I consider a significant loss to the hobby of model railroading.

I'm an occasional author, as yet unpublished, who rereads and "tweaks" WordPerfect files just as you described. Frequently I change "a" to "the" in a sentence in the middle of a page. Must I then print, sign, and date a ten page chapter just to allow some future scholar to formulate imaginary insight into my thoughts and methods in the (admittedly improbable) event that my work is ever published? Life is too short and my resources are too limited for that. Put me firmly in the camp of those who are willing to let the final version stand or fall on its own merits.

For that matter, do manuscript collectors have counterparts who collect everything leading up to the cover photo on the latest *Vogue*? Do those people have to have the model's baby pictures, or are they satisfied with a few frames of her arrival at the cover shoot in baggy sweats and sunglasses? Then there's that high fashion costume. Do they insist on knowing the settings of the loom that wove the cloth. . .? (!)

Maybe collectors of all stripes need a reality check. People, whether they be authors, scientists, toymakers or cardboard box recyclers, do things for their own purposes, usually in the easiest, most efficient ways they can devise. If the results are pleasing to collectors, fine. If they aren't, well, life's like that. Collectors should take what they can legitimately get, and, if it isn't good enough, whip up something more appropriate themselves. Of course, if collectors actually had to produce the things they collect they might have a very different point of view. It might even resemble yours and mine.

That said, I have a small (about 0.229kg) stone to cast at "A Touch of Diphtheria." I can readily accept that the alien cultures postulated by Roger MacBride Allen have eliminated nuclear power plants. By stretching my credibillity to its limit I might even believe that they have foregone the broad spectrum of medical and industrial procedures which either rely on charged particles or

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generate them. When I consider the "normal" environment for spacecraft, however, my suspension of disbelief breaks down. How can critters who expose themselves to solar winds, cosmic rays, Van Allen belts and the bursts of charged particles generated by novae both recent and ancient be ignorant of the dangers of radiation? What registration or licensing authority would allow space and other craft which routinely encounter intense radiation to operate without appropriate detectors (not to mention loud, insistent alarms)? Of course, without the postulated ignorance there would have been no story, which is too bad. The wheels within wheels leading up to the terminally successful con of a con artist were beautifully delineated.

Thanks for your attention, and for a fine magazine.

CHARLES E. (CHUCK) BECKMAN
Nashville, TN

Dear Mr. Schmidt:

I just received my copy of the February issue, and I feel compelled to correct some information from John Cramer's "Alternate View" column. Dr. Cramer's brief summary of current research on moving cosmic strings and possible closed time-like curves and causality violation is lucid and technically accurate, but his attribution of the work is simply wrong.

Dr. Cramer credits cosmic string time travel ideas to "recent work of James Gunn of Harvard." This is inaccurate on two counts: first, while Professor Gunn is associated with the Harvard Smithsonian Center for Astrophysics, he is currently performing research at Princeton University. More importantly, to my knowledge this research does not involve detailed analytical solutions of Einstein's field equations for cosmic strings. The actual closed time-like loop solutions were found by the same individual who first solved the stationary cosmic string problem, J. Richard Gott III, also of Princeton University.

Interestingly, Professor Gott pointed out in his undergraduate course on general relativity that the cone-like geometry of the cosmic string solution is identical to the case of a point mass in a two dimensional "Flatland" universe. Prof. Gott also has the unusual distinction of a citation in the bibliography of *The Wounded Sky*, a Star Trek™ novel by Diane Duane.

Great issue, though! Keep 'em coming!

DOUGLAS NATELSON
Princeton, NJ

Dear Editor:

In "The Alternate View" by John Cramer (February 1993), the impression is given, perhaps inadvertently, that the works of Thorne et al., Shapiro-Teukolsky, and Gunn were the first to suggest that time travel was possible within the framework of general relativity. That suggestion was, however, first formalized in a paper by Kurt Gödel in 1949. Gödel's paper was written as a momentary diversion from his work in logic and the foundations of mathematics, and as part of a tribute to Einstein, his compatriot at the Institute for Ad-

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vanced Study. It was published in brief form in *Reviews of Modern Physics*. The particular solution used involves rotating universes, and shows that in these particular kinds of worlds one can travel to any region in the past, present, and future, and back again, under conditions described by Gödel. This solution is also discussed rather fully in various other drafts by Gödel, now being published as part of his collected works. Without diminishing in any way the work of the first mentioned writers, it is useful to give credit where due, particularly since Gödel's work was regarded by him as just a relaxing interlude in his more arduous labors.

BRUNO W. AUGENSTEIN

Santa Monica, CA

Dear Dr. Schmidt,

Congratulations to the authors for writing, and to you for selecting, an excellent article on computer viruses, past and future ("FAT-Eating Logic Bombs and the Vampire Worm," February 1993). The classification of virus characteristics (pp. 55-56) is exceptionally clear; easily usable for both descriptive and predictive analysis. As a consultant and trainer on computer security and control issues, I've developed similar classifications, but none as complete as Messrs. Rietman & Flynn's. (Such a chart seems obvious when done, but the creative analysis in its development is demanding.)

I have an addition to the authors' reference list. The article repeats the "common knowledge" that Fred Cohen coined "virus" as the name for invasive programs in his 1987 paper. The little-known truth is that Mr. Cohen was preempted in that coinage by at least 17 years. "The Scarred Man," a short story in the May 1970, *Venture Science Fiction* magazine, used a computer program called "VIRUS," with today's meaning (plus some worm aspects), as the primary technical fiction premise. Although somewhat dated by computer microminiaturization, it is still a good story. It raises a still relevant chicken/egg question about virus-prevention experts; a good prospect for an anthology. The author? A young fellow named Greg Benford.

Perhaps, Dr. Schmidt, you could check with Dr. Benford. Was the concept and name his creative product, or did he pick it up from early game hackers? Many others must wonder, as do I, how long the virus idea had been seeping through the software underground.

Thanks to you and your predecessors for 40+ years of educational entertainment.

JIM ALLISON

Indianapolis, IN ■

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UPCOMING EVENTS Anthony Lewis

1-3 October
CONTEXT VI (Central Ohio SF conference) at Hilton Inn North, Columbus, Ohio. Guest of Honor: Frederik Pohl. Info: Context VI, Box 2954, Columbus OH 43216. (614) 263-6089

8-10 October
CONCAT V (Tennessee SF conference) at Holiday Inn Cedar Bluff, Knoxville, Tenn. Guest of Honor: Octavia Butler; Artist Guest of Honor: Pat Morrissey; TM: Wendy Webb. Registration: $25 until 1 October; $30 at the door. Info: ConCat V, 805 College St., Knoxville TN 37921.

15-17 October
NECRONOMICON (Florida Gulf Coast SF conference) at Holiday Inn-Airport, Tampa, Fla. Guests of Honor: Lois McMaster Bujold and Peter David. Registration: $15 until 15 September; $20 thereafter and at the door. Info: Necronomicon '93, Box 2076, Riverview FL 33569. (813) 677-6347

28-31 October
WORLD FANTASY CONVENTION '93 at Radisson South, Bloomington, Minn. Guests of Honor: Poul Anderson, Roger Zelazny, John Crowley; Artist Guest of Honor: Tom Canty; TM: Neil Gaiman. Registration: $75 attending; $40 supporting; limited to 1000 members. Info: World Fantasy Convention, Box 2128, Loop Station, Minneapolis MN 55408.

1-5 September 1994
CONADIAN (52nd World Science Fiction Convention) at Convention Centre, Winnipeg, Manitoba. Guest of Honour: Anne McCaffrey; Artist Guest of Honour: George Barr; Fan Guest of Honour: Robert Runté. Registration: $85 (C$95) adult; $30 (C$35) child until 30 September 1993; Supporting: $25 (C$30). This is the SF universe's annual get-together. Professionals and readers from all over the world will be in attendance. Talks, panels, films, fancy dress competition—the works. Join now and get to nominate and vote for the Hugo Awards and the John W. Campbell Award for Best New Writer. Info: Conadian, Box 2430, Winnipeg MB R3C 4A7 Canada or Box 7111, Fargo ND 58109 (204) 942-9494; FAX (204) 942-3427.

You can send me e-mail about your convention—A.LEWIS20 on the GEnie™ network. When calling conventions for information—do not call collect. ■

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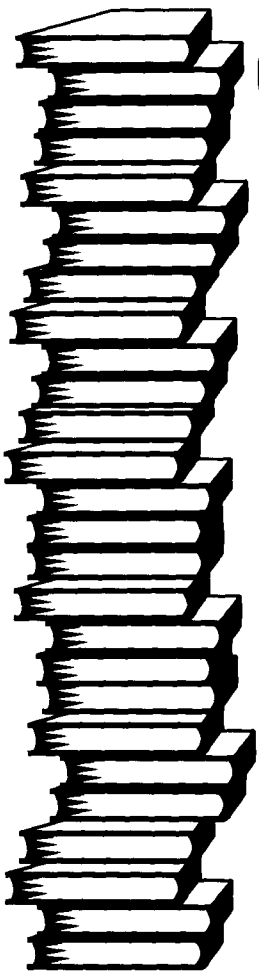

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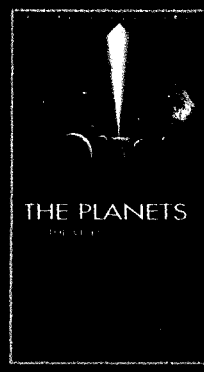

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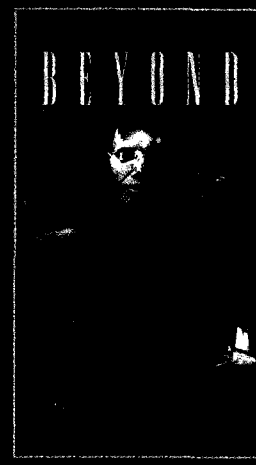

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